Cover Your Acres
Winter Conference

January 19 & 20, 2016

Gateway Civic Center
Oberlin, KS

A cooperative effort between:

K·STATE
Research and Extension

Northwest Kansas Crop Residue Alliance

2016 Proceedings, Vol. 13

Table of Contents

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

Session Summaries

Economics of Soil Fertility Management: With thinning margins there are opportunities to use soil testing and precision technologies in your soil fertility management to add to your bottom line.

Finding Profitability: Using NW Kansas data take a look at drivers in profitability and where producers should be looking as margins tighten

Soil Biology and Carbon in Dryland Ag: Dryland cropping systems are a unique environment when managing as assessing soil biology and soil carbon. Insights from long-term eastern Colorado data will be shared.

Soil pH-Managing the Highs and Lows: High pH has long been an issue in the region, additionally low pH values are becoming more noticeable, especially in long-term no-till. Management strategies for both ends of the pH spectrum will be covered.

Sorghum and Wheat Insect Issues: Take an in-depth look at the management of sugar cane aphid in sorghum and wheat curl mite wheat as well as other pest issues.

Today's Farm Situation vs. the 1980's: Examine the similarities and differences between now and leading into the 1980's farm crisis, and how those aspects should affect your management.

UAVs in Crop Production: UAVs have captured a lot of media attention, take a look at where they might (and might not) fit in crop production.

Weather and Ag in the Tri-State Region: How location specific forecasts, rainfall estimates, and other weather service products developed and their role in agriculture.

Weed Control Strategies: An overview of the latest field trial data for timings, rates, and products to manage troublesome weeds

Weed Resistance: Today and Tomorrow: Past progression of resistance in Kochia and Palmer Amaranth, what the future holds, and how to manage for it.

Wheat Seed Industry Discussion: The wheat variety development and marketing business is changing at a rapid pace. Representatives from public and private seed programs will discussion their future vision and answer audience questions.

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

Presenters

Ignacio Ciampitti– Dr. Ciampitti's program is focusing on assisting agri-business professionals in selecting the best management practices for improving yields under diverse cropping systems scenarios. His research focuses on maximizing yield and closing yield gaps by implementing best management practices, employing review and synthesis -analyses procedures, investigating interactions between crop production factors (genotype x environment x management) and using new technologies On-going projects are: uses of UAVs for detecting production issues and abiotic stresses and development of new tools for rapid screening and predicting yield potential.

David Floyd- David Floyd received his B.S. Degree in Meteorology from the University of Wisconsin in 1974. His weather career in the private sector began as a radio / TV broadcast meteorologist in Wisconsin, then in New York City as an ag/commodity forecaster, and finally in Minneapolis as training manager for a large weather forecasting company (currently DTN / Meteorlogix). In 1994, Dave joined the National Weather Service (NWS) in Norman, OK as a Doppler radar instructor specializing in radar interpretation of severe storms, then later as a forecast meteorologist. In 2002 he moved to the NWS office in Goodland, KS to serve as the Warning Coordination Meteorologist, promoting weather safety/awareness with schools, emergency managers, DOT and local media. Dave is now the Meteorologist-In-Charge at the NWS office in Goodland.

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 served as assistant scientist at K-State's Southwest Research-Extension Center at Tribune, Kansas for 3 years and completed his Ph.D. in Agronomy in 2013. He is an assistant professor of agronomy and Northwest Area Agronomist stationed at the Northwest Research-Extension Center, Colby, Kansas. He has extension agronomy responsibilities for 26 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.

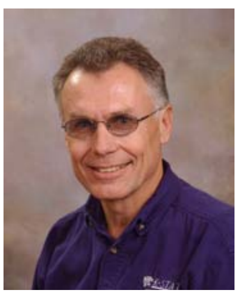
Greg Ibendahl– Gregory Ibendahl is an Associate Extension Professor in Agricultural Economics at Kansas State University. His specialty areas are farm management and agricultural finance. Dr. Ibendahl grew up on a grain and beef farm in Southern Illinois and worked for six years in private industry before returning to graduate school at the University of Illinois. He work experience includes Mobay Chemical and Dekalb Genetics (now part of Monsanto). His Dekalb experience included time working for both the swine division and also the quality assurance seed lab. Dr. Ibendahl has held Extension appointments in Farm Management at the University of Kentucky, Mississippi State University, and now Kansas State University

Daniel Manter- Dan earned his PhD in Forest Science at Oregon State University in 2001 working on the physiological impacts of Swiss needle cast on Douglas-fir. Dan is currently a Research Soil Scientist with the Soil Management and Sugar Beet Research Unit of the USDA Agricultural Research Service in Fort Collins, Colorado. His research focuses on soil biology and plant-microbial interactions aimed at optimizing soil health, defining microbial community structure and function, and disease suppression. Research emphasis is also on developing new management strategies and novel assessment approaches and techniques to promote and maintain soil health and productivity using rapidly developing genetic techniques.

Presenters

Dorivar Ruiz-Diaz-Dr. Dorivar Ruiz Diaz is a soil fertility and nutrient management specialist at Kansas State University. He holds a Ph.D. in soil fertility from Iowa State University and MS in soil fertility from the University of Illinois at Urbana-Champaign. He does research and extension work on the efficient use of fertilizers, phosphorus and micronutrient management, and land application of by-products with an emphasis on crop–available nitrogen.

Phil Stahlman– Phil was raised on his family's small grains and dairy farm in northwest Oklahoma. He received his B.S. in Agronomy from Panhandle State College, M.S. at NDSU, and Ph.D. and Univ. of Wyoming. He is a Professor and Weed Scientist at the K-State Agricultural Research Center-Hays where he has directed weed management research in dryland cropping systems for the past 39 years. Previously he was Agronomist-in-Charge of the Harvey County Experiment Field in Hesston and Assistant Agronomist at the North Central Branch Experiment Station at Minot, ND. His research focuses on crop weed interactions and integrated weed management with recent emphasis on herbicide-induced weed spectrum shifts and the ecology and management of glyphosate resistant kochia.



Curtis Thompson-Curtis Thompson is a Professor and Extension Weed Science Specialist for Kansas State University, Agronomy. Native of North Dakota, he received his BS and MS and NDSU and a Ph.D. at the University of Idaho. His area of focus includes weed management in field crops emphasizing sorghum, corn, sunflower, and resistant weed management. Thompson continues to focus on glyphosate resistant kochia management in western Kansas and has worked extensively on HPPD resistant Palmer amaranth in the central part of the State. Efforts to manage glyphosate resistant Palmer amaranth are intensifying.

Mark Wood-Mark Wood is an Extension Agricultural Economist with the Farm Management Association in Northwest Kansas. He has been assisting Association member families with record keeping, analysis, management and generational transfer issues in Northwest Kansas for over 28 years. He graduated from North Dakota State University with a Master's degree in Agriculture Economics in 1986 and Kansas State University with a Bachelor's degree in Agricultural Economics in 1982. Mark grew up on a farm near Wakefield, Kansas.

Sarah Zukoff-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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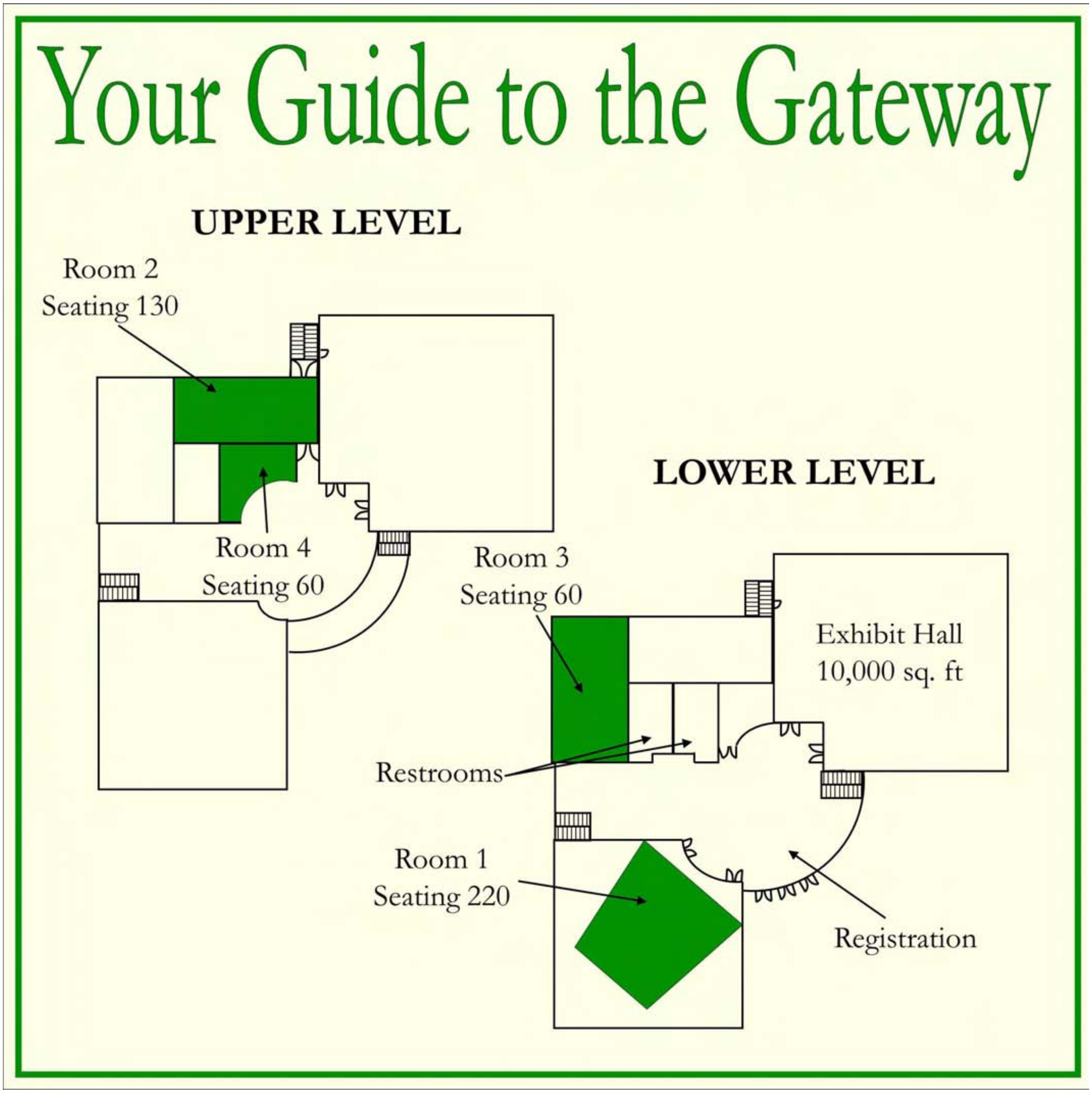

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Economics of Soil Fertility Management

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Current Situation

Crop nutrient recommendations over the years have generally not included crop and fertilizer price as explicit inputs into the decision. Relatively stable relationships of the price ratio of grain to plant nutrients have not necessitated a need until recent years. Grain:Nutrient price ratios for Nitrogen and Phosphorus on a monthly time step since December, 1985 are presented in Figures 1 and 2 for corn and wheat, respectively. The most notable feature in both figures is the grain:phosphorus ratio during the time period of March through September of 2008 when DAP at the Gulf of Mexico was trading near or above $1,000/ton.

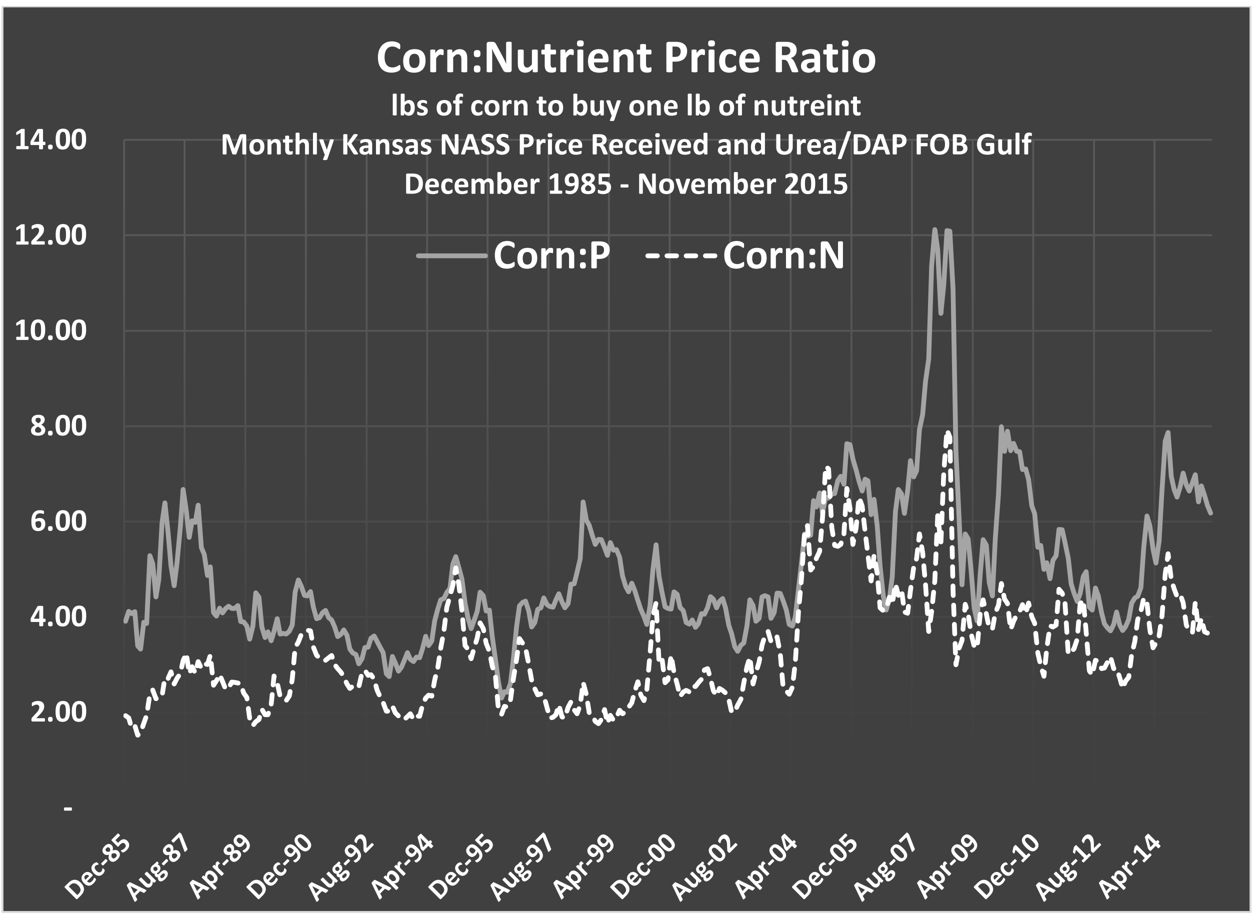

Figure 1. Corn:Nutrient price ratios for nitrogen and phosphorus, December 1985-November 2015.

Today, we are seeing grain:phosphorus price ratios for both wheat and corn that are near the high end of the range since 1985 (excluding the 2008 event). The average wheat:phosphorus ratio since

December of 1985 has been 3.89, while in November of 2015 that ratio was 5.83. The average corn:phosphorus ratio has been 4.97, while in November of 2015 that ratio was 6.18. The grain to nitrogen ratio for corn and wheat are modestly above their long-term averages with corn at 3.81 compared to an average of 3.28 and wheat at 3.60, compared to a long-term average of 2.56.

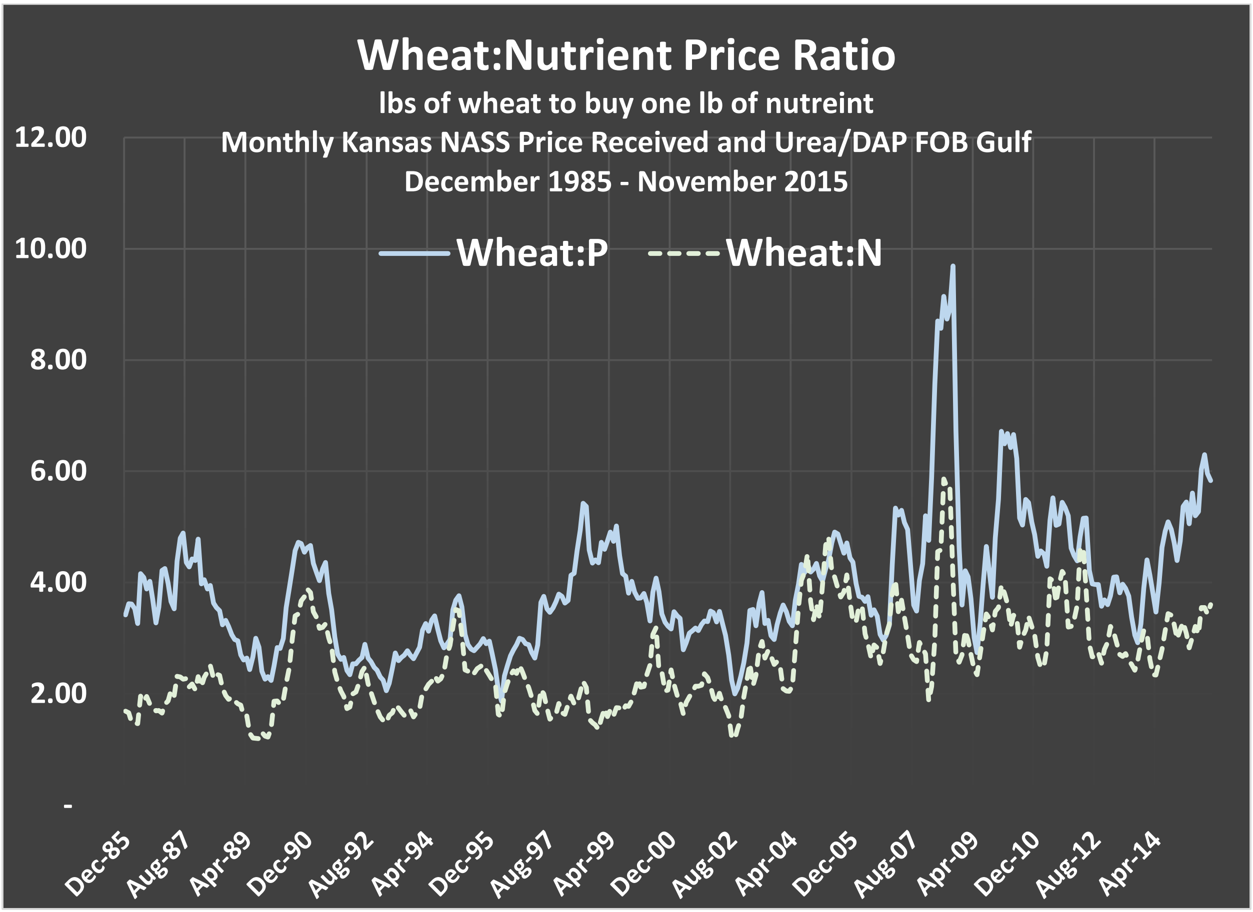

Figure 2. Wheat:Nutrient price ratios for nitrogen and phosphorus, December 1985-November 2015.

Certainly in addition to the current grain:nutrient price ratios, declining commodity prices combined with other relatively constant production expenses are pressuring producer margins for the 2016 crop year. In this scenario, farmers cannot afford to use nutrients inefficiently. Determining appropriate application rates and selecting application methods that minimize loss and maximize effectiveness is essential.

Fertilizer Costs as a Component of Farm Profitability

In analysis of Kansas Farm Management Association records from 2002 through 2013 (Crosby et al., 2007; Dhuyvetter and Smith, 2010; Dhuyvetter and Ward, 2014) fertilizer expenses have averaged around 17% of a producers total costs (Table 1). Interestingly, the percentage of a producers total costs attributed to fertilizer is not markedly different for producers in the top, middle, or bottom third of profitability (data not shown). While the percentage of total cost is relatively constant, in terms of dollars/ac there have been some notable differences betwen producers across the profitability categories. Across the crops and years, producers in the top 1/3 of profitability have spent from

$26.14/acre less to $12.89/acre more on fertilizer expenses than producers in the bottom 1/3 of profitability.

Table 1. Fertilizer expense by profit category, and differences in fertilizer cost, net returns, and yields for KFMA producers 2002-2013.

Non-Irrigated Corn

KFMA Years	Fertilizer Expense by Profit Category			Difference between High and Low 1/3		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
	High 1/3	Mid 1/3	Low 1/3	Fertilizer Cost				
2002-2006	$ 32.34	$ 34.35	$ 48.11	$ (15.77)	-33%	$ 91.13	17%	7%
2007-2009	$ 60.06	$ 57.47	$ 67.48	$ (7.42)	-11%	$ 140.72	5%	17%
2011-2013	$ 85.95	$ 91.43	$ 88.64	$ (2.69)	-3%	$ 149.62	2%	54%

Irrigated Corn

KFMA Years	Fertilizer Expense by Profit Category			Difference between High and Low 1/3		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
	High 1/3	Mid 1/3	Low 1/3	Fertilizer Cost				
2002-2006	$ 41.45	$ 39.13	$ 58.03	$ (16.58)	-29%	$ 138.74	12%	9%
2007-2009	$ 82.37	$ 87.89	$ 108.51	$ (26.14)	-24%	$ 256.98	10%	9%
2011-2013	$ 138.51	$ 124.26	$ 125.62	$ 12.89	10%	$ 334.73	4%	59%

Non-Irrigated Sorghum

KFMA Years	Fertilizer Expense by Profit Category			Difference between High and Low 1/3		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
	High 1/3	Mid 1/3	Low 1/3	Fertilizer Cost				
2002-2006	$ 25.60	$ 25.48	$ 31.44	$ (5.84)	-19%	$ 81.38	7%	24%
2007-2009	$ 40.94	$ 49.38	$ 44.76	$ (3.82)	-9%	$ 126.60	3%	29%
2011-2013	$ 73.79	$ 58.86	$ 64.82	$ 8.97	14%	$ 134.30	7%	37%

Wheat

KFMA Years	Fertilizer Expense by Profit Category			Difference between High and Low 1/3		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
	High 1/3	Mid 1/3	Low 1/3	Fertilizer Cost				
2002-2006	$ 22.09	$ 19.38	$ 25.02	$ (2.93)	-12%	$ 65.39	4%	11%
2007-2009	$ 36.35	$ 46.88	$ 51.67	$ (15.32)	-30%	$ 125.28	12%	21%
2011-2013	$ 54.97	$ 63.73	$ 51.45	$ 3.52	7%	$ 116.24	3%	32%

In general, high profit producers tend to spend less per acre on fertilizer while raising higher crop yields. There are several potential sources of this effect. Differences in fertilizer purchase price as well as management choices of product, rate, and placement all have the opportunity to affect costs and/or yield. On average, the difference in fertilizer costs as a percentage of the difference in net returns between high and low profit producers is between 6 and 9% across the four crop enterprises shown in Table 1.

Understanding Crop Response

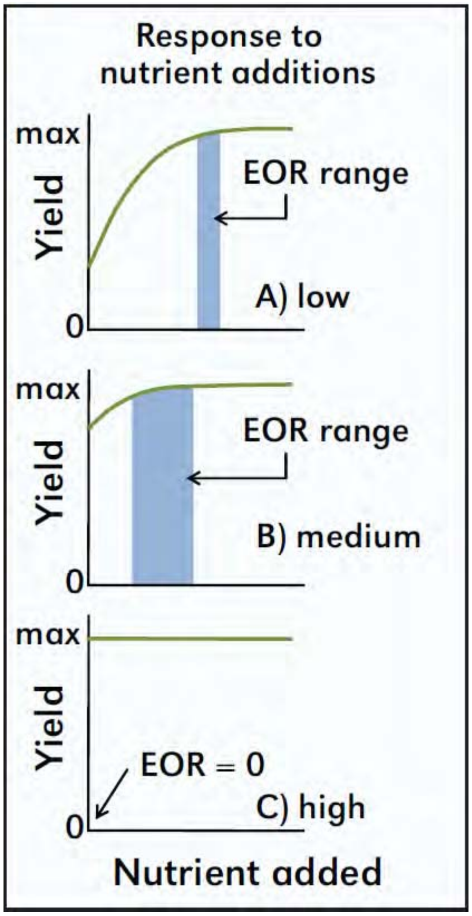

Figure 3. Conceptual model of crop response to soil nutrient supply for A) low, B) medium, and C) high soil test levels. The shaded areas below the curves represent the range of short-term economically optimum rates based on grain:nutrient price ratios. (Murrell and Bruulsema, 2008)

Crop yield response to the addition of fertilizer is determined in large part by the previously existing soil nutrient supply. Murrell and Bruulsema (Figure 3) show the response to fertilizer additions for A) low, B) medium, and C) high soil test levels of a given nutrient (could be N, P, K, S, etc.). At low soil test levels, panel A, one would expect low yields without additional fertilizer. Note that under low soil test conditions, the range of economically optimal rates is relatively narrow, i.e. the optimum rate is minimally affected by grain:nutrient price ratio. Under medium soil test levels, panel B, the expected yield without fertilizer is higher than in low soil test conditions and the range of potentially optimal fertilizer rates is wider. In other words, on medium soil testing soils, in a single-year decision framework, the optimal rate is much more sensitive to grain:nutrient price ratios. As the price ratio increases, the optimal rate declines to the lower end of the range, as the price ratio decreases, the optimal rate increases to the upper end of the range. Under high soil test conditions, where nutrient levels in the soil are sufficient for maximum attainable yields, we would not expect to see a response to added fertilizer as shown in panel C.

Economics of Soil Testing

Higher price ratios increase the potential profits from soil testing at the field or subfield level. In the absence of soil test information some assumption must be made on the nutrient status of the soil. For example, in K-State's nitrogen recommendations, if a producer doesn't know the nitrate nitrogen in the 24" profile, a default value of 30 lbs/ac is assumed. Many producers likely apply the "usual" fertilizer rates from a combination of occasional soil tests and experience. Kastens and Dhuyvetter (2005) used data collected in Northwest Kansas to develop a simulation of 10,000 fields in a typical wheat-corn-fallow rotation. A portion of that analysis was to evaluate the change in profit as actual soil test nitrate and soil test phosphorus varied in comparison to an assumed value. Updating this analysis with current prices produces Figures 4 and 5. As shown in Figure 4, as actual soil test nitrate drops below the assumed value of 40 lb/ac, profits in wheat and corn are reduced by approximately $1.00/ac when there is actually 20 lb/ac in the profile and $5.00/ac when there is essentially no nitrate in the profile. These reductions in profit would be attributed to nitrogen deficiency induced yield reductions. As soil test nitrate values exceed the 40 lb/ac assumption, again, profits are reduced due to the cost of applying unneeded nitrogen.

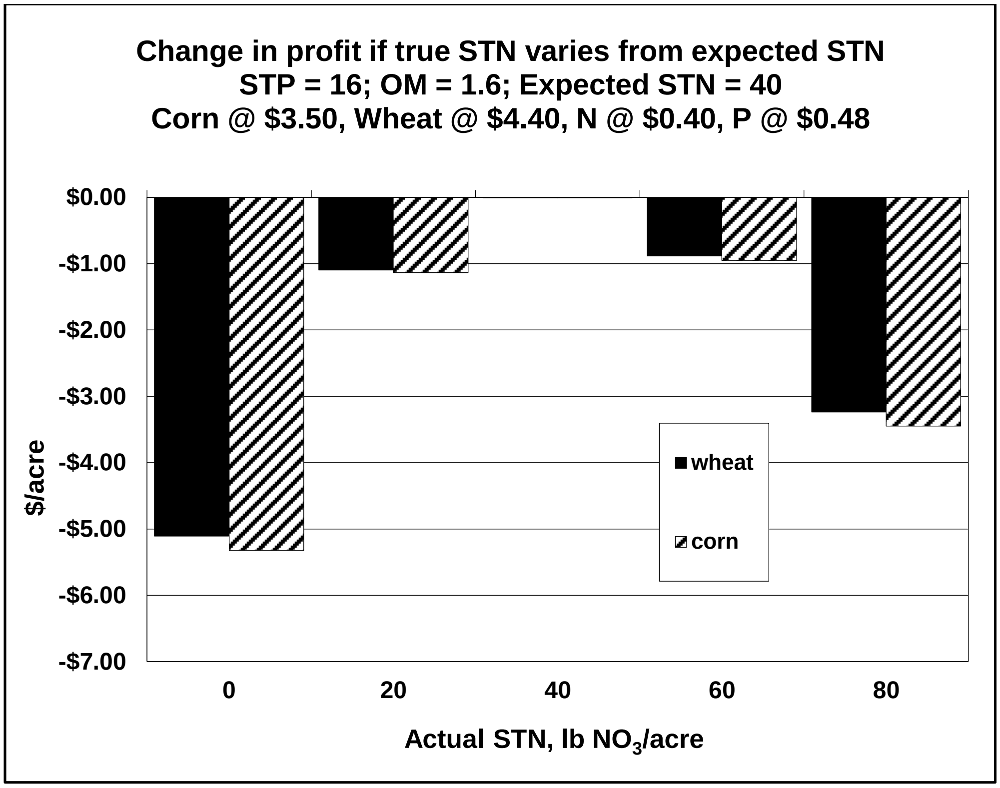

Figure 4. Change in profit if true soil test nitrate (STN) varies from expected STN in a NW Kansas W-C-F rotation.

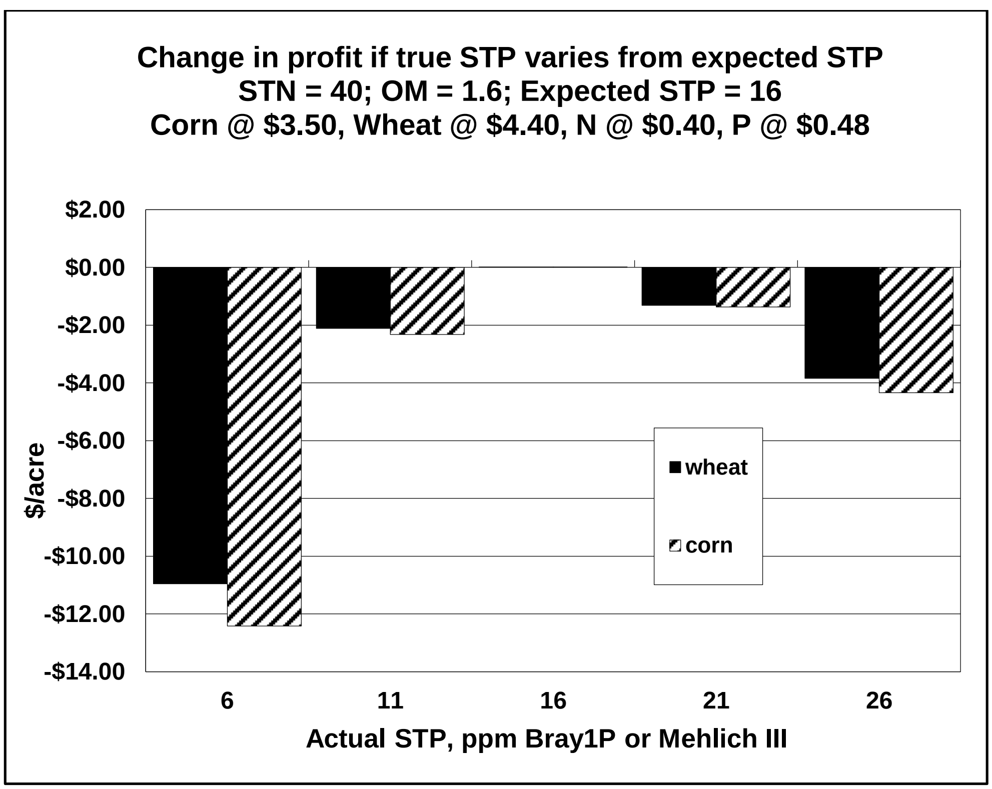

Figure 5.Change in profit if true soil test phosphorus (STP) varies from expected STP in a NW Kansas W-C-F rotation.

The value of soil sample information is shown to be of greater economic value when pertaining to soil test phosphorus (Figure 5). As actual soil test level drops below the assumed value of 16 ppm Bray1P or Mehlich III, profit for wheat and corn is reduced in excess of $10.00/ac due to phosphorus deficiency induced yield reductions. Conversely, as actual soil test levels rise above the assumed value of 16 ppm, profits are reduced due to the cost of unneeded phosphorus application. The above scenarios give some indication on the potential profitability of soil sampling to identify fields and areas within fields that are both greater than and less than the soil test value for N and P that might otherwise be assumed for making nutrient recommendations.

Soil Testing Data Quality

Investing in a soil testing program requires expense in the forms of sampling equipment, sampling labor, and laboratory fees. The largest challenges to obtaining high quality soil testing data are within the process of physically obtaining the soil sample in the field. Maintaining a consistent and appropriate sampling depth is critical to obtaining a lab result that is consistent with its intended use in nutrient recommendations, i.e. if the recommendations are based off a 6" sample, it's important to have a lab result representative of cores taken to a depth of 6". In long-term no-till this becomes especially important as nutrient stratification, especially with respect to phosphorus and soil pH, creates a strong gradient across the shallow depths of the soil profile. In a highly stratified field, collecting a soil core that is 1" short or 1" long can affect lab results and nutrient recommendations. The second main consideration is obtaining a sample consisting of an adequate number of cores to minimize the variability induced by small scale spatial variability in the field. The more cores used to comprise a sample the less influence any one core has on the overall mean. This is important to counteract the effects of small scale spatial variability both from natural soil processes as well as manmade variability, such as that created by banding fertilizer or grazing livestock. Previous work in phosphorus sampling has shown that a minimum of 15 cores is a reasonable number to minimize sample error without dramatically affecting labor requirements (Figure 6). The marginal costs of collecting 15 cores vs. 10 appears to be relatively minor for the increase in data quality.

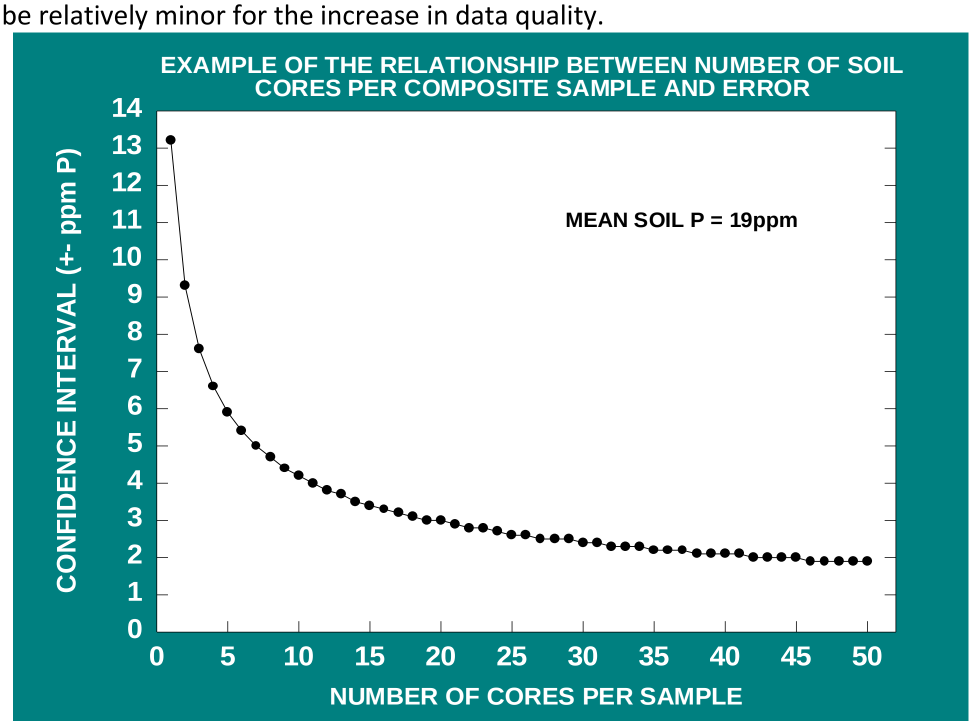

Figure 6. Confidence interval around a lab result for STP as a function of cores comprising the sample.

Products and Placement

Under the current economic conditions it's important that producers compare all available forms of plant nutrients on a pound for pound basis. Liquid and dry forms of plant nutrients are equivalent as long as their application method accuracies and efficiencies are comparable. There can be a tendency to consider nutrient products advertised has having "enhanced efficiency" or "plant availability" whereby the producer can cut back on rates of actual nutrient applied due to these characteristics. Producers should always do the math on the nutrient analysis and weight/acre application rate of the product to compare the product on a pound for pound basis. Ortho vs. polyphosphate fertilizers are often a topic of discussion in this regard. While most orthophosphate fertilizers allow higher concentrations to be placed near the seed due to their lower salt concentration, there is effectively no difference in plant availability as polyphosphates convert to orthophosphates (the form absorbed by plants) within a matter of days depending upon soil moisture and temperature conditions.

In the situation where a producer has land relatively low in a given nutrient and has financial or other limitations in applying the full recommendation of that nutrient, placement by banding can improve the relative effectiveness of that applied nutrient. Figure 7, adapted from Anghinoni and Barber, 1980, is a conceptual representation of yield response for high rate of applied nutrient over a large portion of the soil volume compared to a low rate of applied nutrient.

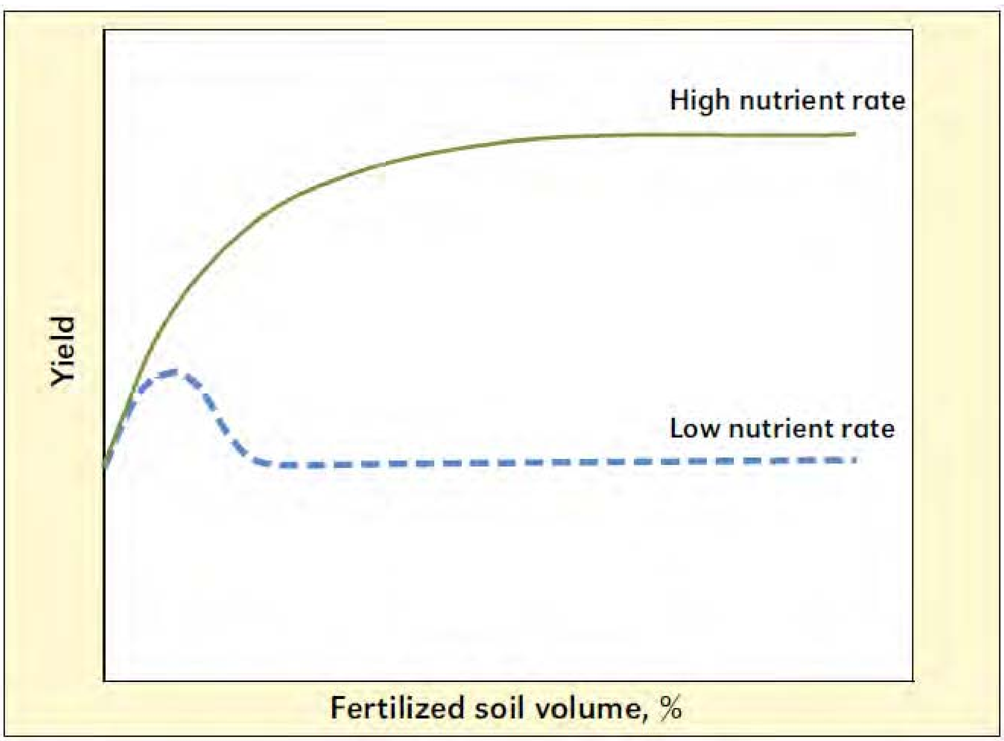

Figure 7. Conceptual model of nutrient rate and placement in the soil volume on crop yield (adapted from Anghinoni and Barber, 1980).

When the low rate of applied nutrient is contained within a relatively smaller soil volume, a higher yield response will typically be observed. In the Great Plains, this would be particularly true with phosphorus applications. The response to in-furrow applications of phosphorus is common in soils at less than sufficiency soil test levels (<20 ppm Bray 1P or Mehlich III). The probability of seeing a response to banded phosphorus increases as soil test phosphorus decreases. Manure is very valuable plant nutrient resource that should be considered for economic evaluation as well and used if possible.

Summary:

It's important to remember that higher grain:nutrient price ratios do not change the amount of N or P removed by a crop from the soil. Higher price ratios however, do increase the potential profitability of implementing a soil sampling program for determining optimum fertility rates, provided that the sampling program collects data of good quality. Producers should keep in mind that fertilizer applications that are less than crop removal will result in mining of soil reserves, regardless of product and application method. In medium and high testing soils, reduced rates are a potential remedy to narrow margins in the short term, but producers should keep in mind the long-term consequences. In low testing soils, the application of necessary crop nutrients is economically preferable to reducing nutrient application and in some cases placement can be used to improve crop response when less than recommended rates are to be applied.

Acknowledgements:

The author extends his thanks to Terry Kastens and Kevin Dhuyvetter, emeritus and former faculty, respectively, in the KSU Department of Agricultural Economics for sharing their data and prior work on soil testing economics.

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"Finding Profitability?"

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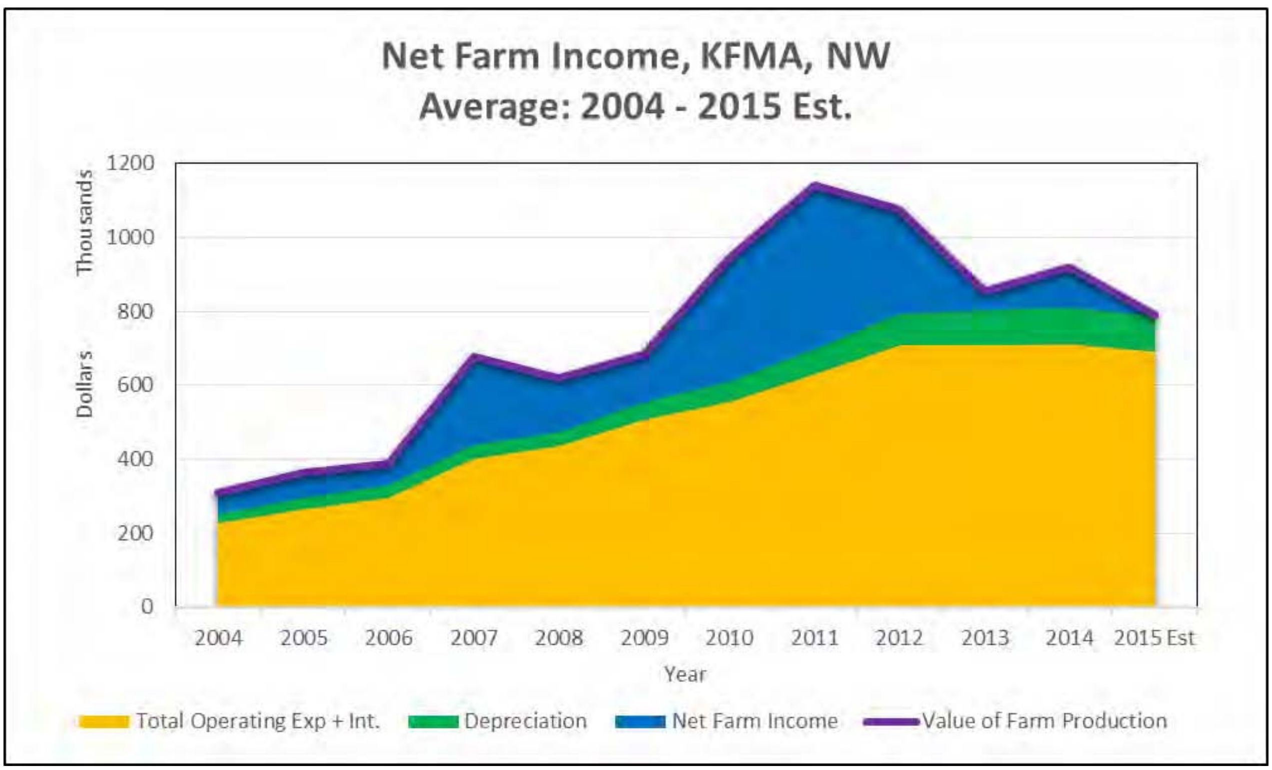
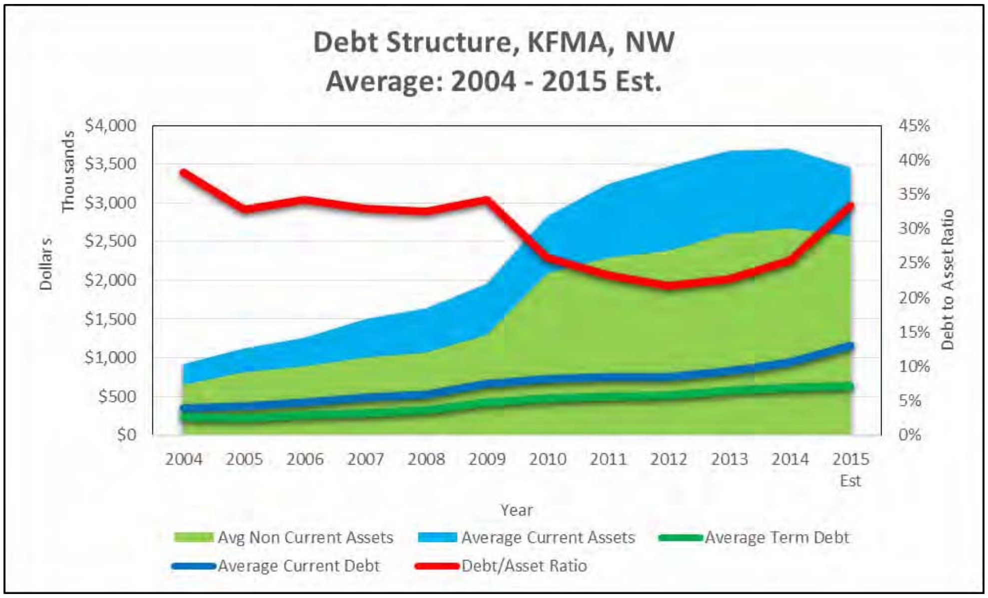
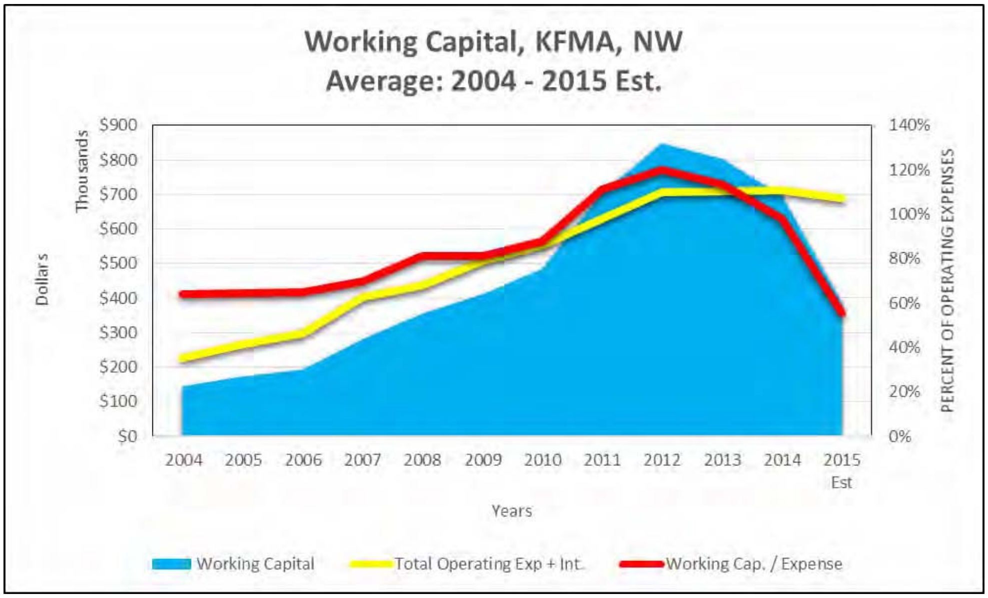
The following are examples of charts and tables that are the basis for my presentation at the 2016 Cover Your Acres conference in Oberlin, KS. I'll begin with a review of the average financial performance of the Kansas Farm Management Association, Northwest membership from 2004 through an estimate of 2015. The value of history can be the benefit of perspective. The 2007 through 2012 analysis years demonstrate income and equity accumulation beyond historic proportions. The recent and projected declines simply return producers to a longer term income and financial situation. Unfortunately, the excessive income will have to be "worked out" of the system like all business cycles. Who will find success in times like these? Who will simply hold on until better times return? These questions and more will be discussed in this presentation.

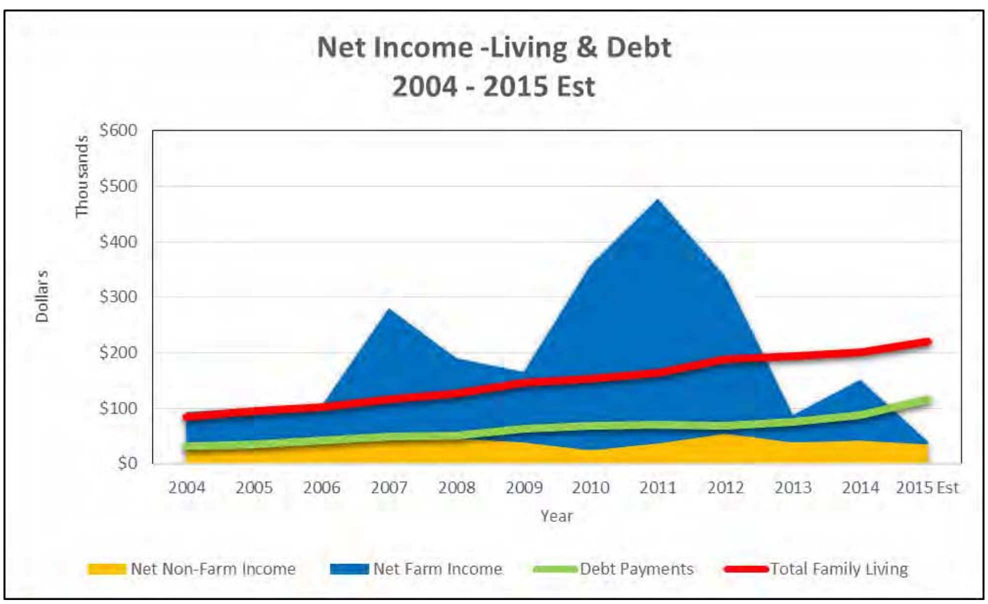
I look forward to visiting with many of you at the Cover Your Acres Conference. Let's keep our chin up and forge ahead. That's what successful people do…..

Mark A. Wood




Debt Structure, KFMA, NW
Average: 2004 - 2015 Est.
Dollars
Thousands
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Debt to Asset Ratio
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 Est
Year
Avg Non Current Assets
Average Current Assets
Average Term Debt
Average Current Debt
Debt/Asset Ratio


Working Capital, KFMA, NW
Average: 2004 - 2015 Est.
Dollars
Thousands
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
140%
120%
100%
80%
60%
40%
20%
0%
PERCENT OF OPERATING EXPENSES
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 Est
Years
Working Capital
Total Operating Exp + Int.
Working Cap. / Expense


Net Income -Living & Debt
2004 - 2015 Est
Dollars
Thousands
$600
$500
$400
$300
$200
$100
$0
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 Est
Year
Net Non-Farm Income
Net Farm Income
Debt Payments
Total Family Living

2014 Data - Northwest Kansas Enterprise Summary	Kansas Farm Management Association Annual ProfitLink Summary NON-IRRIGATED NO-TILL CORN			
	PROFIT CATEGORY (per Acre)			Difference
	High 1/3	Mid 1/3	Low 1/3	$
Number of Farms	9	10	10	
Enterprise Acres	801	660	152	649
Acres Owned	205	179	44	161
Acres Rented	596	481	108	488
Yield/Acre	85.42	60.90	50.65	34.77
Operator Percentage	83.97 %	90.25 %	84.26 %	-0.29 %
Price/Bushel	$3.86	$4.03	$3.95	($0.09)
INCOME				
Corn (Oper Shr)	272.02	224.34	158.18	113.84
Government Payments	2.17	0.00	0.00	2.17
Crop Insurance Proceeds	28.82	35.91	36.58	-7.76
Other Income	0.53	2.75	8.98	-8.45
GROSS INCOME	**$303.54**	**$263.00**	**$203.75**	**$99.79**
EXPENSE				
Labor Hired	8.03	13.22	13.90	-5.87
General Machinery Repairs	11.60	19.34	24.84	-13.24
Interest Paid	8.97	6.69	13.04	-4.07
Seed/Other Crop Expense	44.24	37.35	42.74	1.50
Crop Insurance	6.90	17.94	19.91	-13.01
Fertilizer/Lime	41.05	38.61	51.20	-10.15
Machine Hire - Lease	12.23	6.12	10.69	1.53
Fees, Publications, Travel	2.22	2.42	3.09	-0.87
Gas, Fuel, Oil	10.80	18.38	12.14	-1.33
Crop Storage & Marketing	0.08	2.21	0.00	0.08
Personal Property Tax	1.95	1.74	3.02	-1.07
General Farm Insurance	3.65	4.93	6.33	-2.68
Utilities	1.85	2.22	2.86	-1.01
Cash Farm Rent	21.74	32.17	12.40	9.34
Herbicide, Insecticide	26.59	41.45	81.86	-55.27
Auto Expense	1.07	0.22	1.79	-0.72
Depreciation	21.73	40.58	39.99	-18.25
Real Estate Tax	0.91	1.41	0.50	0.41
Unpaid Operator Labor	16.72	20.10	27.13	-10.42
Interest Charge	7.08	17.27	14.57	-7.49
Land Charge	19.11	18.61	8.99	10.12
TOTAL EXPENSE	**$268.53**	**$342.97**	**$390.99**	**($122.46)**
NET RETURN TO MANAGEMENT	**$35.01**	**($79.98)**	**($187.24)**	**$222.25**
NET RETURN TO LABOR-MGMT	**$59.76**	**($46.66)**	**($146.21)**	**$205.97**

2014 Data - Northwest Kansas Enterprise Summary	Kansas Farm Management Association Annual ProfitLink Summary NON-IRRIGATED NO-TILL GRAIN SORGHUM			
	PROFIT CATEGORY (per Acre)			
	High 1/3	Mid 1/3	Low 1/3	Difference
Number of Farms	12	12	12	
Enterprise Acres	492	724	432	60
Acres Owned	144	167	166	-22
Acres Rented	349	557	267	82
Yield/Acre	83.29	78.19	49.61	33.68
Operator Percentage	84.37 %	85.46 %	87.02 %	-2.65 %
Price/Bushel	$3.92	$4.05	$3.85	$0.07
INCOME				
Grain Sorghum (Oper Shr)	271.31	270.53	167.13	104.18
Government Payments	0.92	0.00	0.00	0.92
Crop Insurance Proceeds	24.63	5.73	25.45	-0.82
Other Income	1.59	2.02	4.03	-2.44
GROSS INCOME	**$298.45**	**$278.28**	**$196.61**	**$101.84**
EXPENSE				
Labor Hired	6.74	12.26	16.97	-10.23
General Machinery Repairs	13.73	16.21	20.44	-6.72
Interest Paid	4.28	7.22	7.31	-3.03
Seed/Other Crop Expense	9.24	7.68	10.76	-1.53
Crop Insurance	10.22	18.01	14.62	-4.40
Fertilizer/Lime	35.40	27.34	31.97	3.44
Machine Hire - Lease	12.12	4.89	14.34	-2.21
Fees, Publications, Travel	2.44	2.58	2.47	-0.03
Gas, Fuel, Oil	10.03	17.79	12.66	-2.63
Crop Storage & Marketing	0.19	5.11	0.17	0.02
Personal Property Tax	0.92	2.62	2.60	-1.68
General Farm Insurance	4.02	3.60	5.16	-1.14
Utilities	1.62	2.75	2.51	-0.89
Cash Farm Rent	9.17	21.60	10.18	-1.01
Herbicide, Insecticide	35.94	46.04	52.84	-16.90
Auto Expense	0.61	0.45	0.56	0.06
Depreciation	21.26	35.28	31.92	-10.66
Real Estate Tax	2.14	1.06	0.86	1.28
Unpaid Operator Labor	22.73	21.78	25.48	-2.76
Interest Charge	9.23	12.80	12.12	-2.89
Land Charge	22.81	17.76	16.11	6.69
TOTAL EXPENSE	**$234.84**	**$284.83**	**$292.05**	**($57.21)**
NET RETURN TO MANAGEMENT	**$63.61**	**($6.54)**	**($95.44)**	**$159.05**
NET RETURN TO LABOR-MGMT	**$93.08**	**$27.50**	**($52.99)**	**$146.07**

2014 Data - Northwest Kansas
Enterprise Summary

Kansas Farm Management Association
Annual ProfitLink Summary
NON-IRRIGATED WHEAT

	PROFIT CATEGORY (per Acre)			
	High 1/3	**Mid 1/3**	**Low 1/3**	**Difference**
Number of Farms	11	11	12	
Enterprise Acres	936	662	570	365
Acres Owned	361	324	144	218
Acres Rented	574	338	426	148
Yield/Acre	28.36	36.14	23.10	5.26
Operator Percentage	83.56 %	81.25 %	71.16 %	12.40 %
Price/Bushel	$5.97	$5.79	$5.82	$0.15
INCOME				
Wheat (Oper Shr)	139.81	167.67	96.04	43.77
Crop Insurance Proceeds	32.95	13.67	38.12	-5.16
Other Income	2.36	2.49	2.50	-0.14
GROSS INCOME	**$175.12**	**$183.83**	**$136.66**	**$38.46**
EXPENSE				
Labor Hired	3.79	5.09	14.89	-11.10
General Machinery Repairs	12.66	25.71	18.40	-5.74
Interest Paid	2.30	7.41	6.47	-4.17
Seed/Other Crop Expense	4.99	11.49	7.39	-2.40
Crop Insurance	10.99	12.49	15.23	-4.25
Fertilizer/Lime	14.14	31.96	32.84	-18.70
Machine Hire - Lease	13.84	5.04	9.86	3.98
Fees, Publications, Travel	2.01	1.87	2.06	-0.05
Gas, Fuel, Oil	13.64	14.89	18.56	-4.92
Crop Storage & Marketing	0.00	0.02	0.05	-0.05
Personal Property Tax	0.61	2.70	2.25	-1.63
General Farm Insurance	3.57	5.12	5.26	-1.69
Utilities	0.87	0.83	0.64	0.23
Cash Farm Rent	2.42	6.82	0.61	1.81
Herbicide, Insecticide	8.73	15.44	31.99	-23.26
Auto Expense	0.28	0.94	0.86	-0.58
Depreciation	29.27	31.50	43.89	-14.62
Real Estate Tax	0.22	1.24	1.14	-0.92
Unpaid Operator Labor	13.68	20.04	20.77	-7.09
Interest Charge	11.14	8.91	14.65	-3.51
Land Charge	15.73	26.40	8.36	7.37
TOTAL EXPENSE	**$164.87**	**$235.92**	**$256.17**	**($91.30)**
NET RETURN TO MANAGEMENT	**$10.26**	**($52.09)**	**($119.51)**	**$129.77**
NET RETURN TO LABOR-MGMT	**$27.72**	**($26.96)**	**($83.85)**	**$111.57**

2014 Data - Northwest Kansas
Enterprise Summary

Kansas Farm Management Association
Annual ProfitLink Summary
NON-IRRIGATED NO-TILL WHEAT

	PROFIT CATEGORY (per Acre)			
	High 1/3	**Mid 1/3**	**Low 1/3**	**Difference**
Number of Farms	13	13	14	
Enterprise Acres	998	1,184	918	79
Acres Owned	322	411	102	220
Acres Rented	675	773	816	-141
Yield/Acre	31.13	34.16	29.07	2.06
Operator Percentage	77.10 %	87.61 %	87.16 %	-10.06 %
Price/Bushel	$6.12	$6.03	$5.76	$0.36
INCOME				
Wheat (Oper Shr)	141.72	178.47	140.73	0.99
Government Payments	0.00	0.86	0.00	0.00
Crop Insurance Proceeds	34.13	18.91	26.00	8.12
Other Income	2.48	3.04	3.00	-0.52
GROSS INCOME	**$178.33**	**$201.27**	**$169.73**	**$8.60**
EXPENSE				
Labor Hired	10.11	6.96	8.57	1.53
General Machinery Repairs	15.68	14.57	19.38	-3.70
Interest Paid	6.35	9.68	5.70	0.66
Seed/Other Crop Expense	6.46	7.81	9.37	-2.92
Crop Insurance	14.75	18.15	14.40	0.34
Fertilizer/Lime	27.45	40.17	42.89	-15.44
Machine Hire - Lease	10.86	17.77	7.05	3.81
Fees, Publications, Travel	1.75	1.81	2.22	-0.47
Gas, Fuel, Oil	10.10	9.46	14.11	-4.01
Crop Storage & Marketing	0.02	0.01	1.47	-1.45
Personal Property Tax	1.66	1.33	1.72	-0.06
General Farm Insurance	3.51	3.88	3.96	-0.45
Utilities	0.54	0.81	0.68	-0.14
Cash Farm Rent	0.22	12.51	36.88	-36.66
Herbicide, Insecticide	12.15	31.30	31.76	-19.61
Auto Expense	0.52	0.99	0.51	0.01
Depreciation	24.11	20.58	41.02	-16.90
Real Estate Tax	0.04	0.53	0.36	-0.32
Unpaid Operator Labor	14.18	14.75	20.81	-6.63
Interest Charge	7.23	6.34	16.11	-8.88
Land Charge	13.60	19.68	5.86	7.73
TOTAL EXPENSE	**$181.28**	**$239.09**	**$284.83**	**($103.55)**
NET RETURN TO MANAGEMENT	**($2.95)**	**($37.81)**	**($115.09)**	**$112.14**
NET RETURN TO LABOR-MGMT	**$21.33**	**($16.10)**	**($85.71)**	**$107.04**

2014 Data - Northwest Kansas
Enterprise Summary
I

Kansas Farm Management Association
Annual ProfitLink Summary
IRRIGATED CORN
PROFIT CATEGORY (per Acre)

	High 1/3	Mid 1/3	Low 1/3	Difference
Number of Farms	11	12	12	
Enterprise Acres	485	600	396	89
Acres Owned	211	173	146	65
Acres Rented	274	427	249	24
Yield/Acre	128.20	207.26	186.82	-58.62
Operator Percentage	91.71 %	89.16 %	81.09 %	10.62 %
Price/Bushel	$4.11	$4.08	$3.96	$0.15
INCOME				
Corn (Oper Shr)	499.13	753.15	590.27	-91.14
Crop Insurance Proceeds	252.37	10.46	49.27	203.11
Other Income	5.21	-7.15	2.92	2.29
GROSS INCOME	**$756.71**	**$756.46**	**$642.46**	**$114.25**
EXPENSE				
Labor Hired	40.10	21.37	30.83	9.27
General Machinery Repairs	29.58	24.81	44.42	-14.83
Irrigation Machinery Repairs	13.62	16.52	20.91	-7.29
Interest Paid	24.48	15.48	25.77	-1.29
Feed	0.00	0.00	0.06	-0.06
Seed/Other Crop Expense	101.68	98.96	110.43	-8.76
Crop Insurance	27.14	15.14	36.18	-9.04
Fertilizer/Lime	102.97	98.34	130.73	-27.77
Machine Hire - Lease	3.72	22.90	14.53	-10.81
Fees, Publications, Travel	4.67	5.62	4.36	0.31
Gas, Fuel, Oil	27.90	30.14	34.41	-6.51
Irrigation Gas, Fuel, Oil	29.29	30.97	54.27	-24.98
Crop Storage & Marketing	4.88	40.71	0.89	3.99
Personal Property Tax	2.51	4.08	6.63	-4.12
General Farm Insurance	14.97	11.89	16.38	-1.42
Utilities	5.20	10.36	6.32	-1.13
Cash Farm Rent	28.13	62.19	10.75	17.39
Herbicide, Insecticide	57.32	95.13	89.63	-32.31
Conservation	0.00	2.94	0.00	0.00
Auto Expense	0.49	1.93	2.82	-2.33
Depreciation	88.67	79.89	73.44	15.22
Real Estate Tax	3.58	3.40	0.03	3.55
Unpaid Operator Labor	30.62	60.27	47.23	-16.61
Interest Charge	25.64	36.19	35.58	-9.93
Land Charge	40.62	46.26	49.05	-8.43
TOTAL EXPENSE	**$707.78**	**$835.50**	**$845.65**	**($137.87)**
NET RETURN TO MANAGEMENT	**$48.93**	**($79.05)**	**($203.20)**	**$252.13**
NET RETURN TO LABOR-MGMT	**$119.65**	**$2.59**	**($125.14)**	**$244.79**

2014 Data - Northwest Kansas
Enterprise Summary
I

Kansas Farm Management Association
Annual ProfitLink Summary
IRRIGATED SOYBEANS
PROFIT CATEGORY (per Acre)

	High 1/3	Mid 1/3	Low 1/3	Difference
Number of Farms	5	6	6	
Enterprise Acres	474	500	283	191
Acres Owned	153	97	105	48
Acres Rented	321	404	178	143
Yield/Acre	65.24	61.90	59.73	5.51
Operator Percentage	87.32 %	96.14 %	79.39 %	7.93 %
Price/Bushel	$8.87	$9.62	$9.27	($0.40)
INCOME				
Soybeans (Oper Shr)	498.99	573.16	437.37	61.62
Crop Insurance Proceeds	25.29	9.46	5.89	19.40
Other Income	0.29	3.53	1.32	-1.03
GROSS INCOME	**$524.57**	**$586.16**	**$444.58**	**$79.99**
EXPENSE				
Labor Hired	13.75	19.76	14.90	-1.15
General Machinery Repairs	10.58	19.32	39.19	-28.61
Irrigation Machinery Repairs	55.92	16.28	19.31	36.61
Interest Paid	4.70	10.23	19.27	-14.57
Seed/Other Crop Expense	55.74	82.87	87.75	-32.02
Crop Insurance	1.99	8.51	27.60	-25.62
Fertilizer/Lime	34.60	42.46	62.03	-27.44
Machine Hire - Lease	3.62	2.78	10.63	-7.01
Fees, Publications, Travel	2.84	4.62	2.45	0.39
Gas, Fuel, Oil	18.70	28.15	24.45	-5.75
Irrigation Gas, Fuel, Oil	31.28	10.72	35.66	-4.38
Crop Storage & Marketing	0.00	1.43	0.00	0.00
Personal Property Tax	2.42	3.98	3.41	-0.99
General Farm Insurance	4.98	7.83	14.24	-9.26
Utilities	6.57	19.24	11.32	-4.75
Cash Farm Rent	9.24	109.42	1.89	7.35
Herbicide, Insecticide	34.18	32.29	53.42	-19.24
Auto Expense	1.51	1.55	4.55	-3.04
Depreciation	57.85	64.26	46.85	11.00
Real Estate Tax	0.00	4.06	2.25	-2.25
Unpaid Operator Labor	23.21	42.50	34.01	-10.81
Interest Charge	26.47	28.41	21.25	5.22
Land Charge	32.78	16.65	42.30	-9.52
TOTAL EXPENSE	**$432.92**	**$577.33**	**$578.73**	**($145.81)**
NET RETURN TO MANAGEMENT	**$91.65**	**$8.82**	**($134.15)**	**$225.80**
NET RETURN TO LABOR-MGMT	**$128.60**	**$71.09**	**($85.23)**	**$213.83**

2014 Data - Northwest Kansas Enterprise Summary I	Kansas Farm Management Association Annual ProfitLink Summary IRRIGATED WHEAT			
	PROFIT CATEGORY (per Acre)			
	High 1/3	Mid 1/3	Low 1/3	Difference
Number of Farms	6	6	7	
Enterprise Acres	294	123	128	165
Acres Owned	135	30	17	118
Acres Rented	159	93	111	48
Yield/Acre	55.73	55.66	41.37	14.36
Operator Percentage	87.53 %	88.88 %	84.44 %	3.09 %
Price/Bushel	$6.10	$5.85	$5.59	$0.51
INCOME				
Wheat (Oper Shr)	304.05	290.57	188.21	115.84
Crop Insurance Proceeds	0.83	4.73	38.33	-37.49
Other Income	3.40	4.59	4.11	-0.71
GROSS INCOME	**$308.29**	**$299.89**	**$230.65**	**$77.64**
EXPENSE				
Labor Hired	12.28	23.27	6.55	5.73
General Machinery Repairs	17.18	18.26	29.73	-12.55
Irrigation Machinery Repairs	11.65	14.67	30.59	-18.94
Interest Paid	6.38	12.74	9.68	-3.30
Seed/Other Crop Expense	8.43	13.09	15.59	-7.16
Crop Insurance	10.61	21.44	12.97	-2.37
Fertilizer/Lime	54.29	25.82	61.52	-7.23
Machine Hire - Lease	10.32	14.67	6.13	4.20
Fees, Publications, Travel	1.75	2.25	5.70	-3.96
Gas, Fuel, Oil	25.57	17.54	23.81	1.76
Irrigation Gas, Fuel, Oil	5.40	32.34	32.42	-27.02
Crop Storage & Marketing	0.00	1.14	0.00	0.00
Personal Property Tax	1.02	1.38	3.88	-2.86
General Farm Insurance	7.73	8.67	6.57	1.16
Utilities	1.79	2.49	4.39	-2.60
Cash Farm Rent	0.00	12.64	5.55	-5.55
Herbicide, Insecticide	10.07	14.08	22.87	-12.80
Auto Expense	0.19	1.33	1.34	-1.15
Depreciation	37.48	54.29	42.19	-4.71
Real Estate Tax	2.68	3.03	0.00	2.68
Unpaid Operator Labor	22.16	30.98	42.39	-20.23
Interest Charge	14.13	17.94	18.88	-4.75
Land Charge	36.52	18.81	6.23	30.29
TOTAL EXPENSE	**$297.63**	**$362.86**	**$388.98**	**($91.35)**
NET RETURN TO MANAGEMENT	**$10.66**	**($62.96)**	**($158.34)**	**$169.00**
NET RETURN TO LABOR-MGMT	**$45.10**	**($8.71)**	**($109.39)**	**$154.49**

2014 Data - Northwest Kansas Enterprise Summary	Kansas Farm Management Association Annual ProfitLink Summary BEEF COWS - CALVES			
	PROFIT CATEGORY (per Cow)			
	High 1/3	Mid 1/3	Low 1/3	Difference
Number of Farms	6	6	6	
Number of Cows in Herd	127	208	128	0
Number of Calves Sold	100	180	72	27
Avg Weight of Calves Sold	565	599	561	4
Calves Sales Price / CWT	207.62	226.68	208.78	-1.16
GROSS INCOME	**$1,440.45**	**$1,260.15**	**$1,453.60**	**($13.15)**
EXPENSE				
Labor Hired	64.66	58.50	39.29	25.37
General Machinery Repairs	50.55	33.10	89.42	-38.87
Interest Paid	19.78	31.47	47.87	-28.09
Feed	237.44	305.55	570.58	-333.14
Pasture	198.53	190.99	164.52	34.01
Machine Hire - Lease	13.52	2.92	13.44	0.08
Fees, Publications, Travel	6.24	10.13	9.53	-3.29
Vet Medicine/Drugs	36.38	21.53	37.94	-1.56
Lvstk Marketing/Breeding	20.32	24.07	32.55	-12.23
Gas, Fuel, Oil	26.13	25.83	42.92	-16.78
Personal Property Tax	4.77	4.00	10.44	-5.67
General Farm Insurance	12.54	23.24	27.48	-14.94
Utilities	18.50	18.49	33.65	-15.14
Auto Expense	1.80	9.10	5.02	-3.22
Depreciation	38.39	70.51	92.81	-54.42
Real Estate Tax	0.00	0.00	0.78	-0.78
Unpaid Operator Labor	196.10	161.53	149.86	46.24
Interest Charge	129.62	128.77	168.54	-38.93
TOTAL EXPENSE	**$1,075.27**	**$1,119.72**	**$1,536.63**	**($461.36)**
NET RETURN TO MANAGEMENT	**$365.18**	**$140.43**	**($83.04)**	**$448.22**
NET RETURN TO LABOR-MGMT	**$625.94**	**$360.46**	**$106.12**	**$519.82**

SOIL BIOLOGY AND CARBON IN DRYLAND AGRICULTURE

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Abstract
The goal of this paper is to explore potential management strategies in dryland agriculture that can promote soil health and crop productivity. Traditional crop production in the semiarid Great Plains consists of conventional tillage management of winter wheat (*Triticum aestivum* L.) - summer fallow. In this study, we explore the potential of increased cropping intensity (i.e., reduced fallow frequency) to promote soil health and crop productivity. At all three dryland sites studied in eastern Colorado, increasing cropping intensity resulted in increasing wheat yields, increased soil carbon sequestration, and the promotion of beneficial bacteria in the soil.

Introduction

Soil organic matter is a critical component of all aspects of soil health (Johnston 1986) and is a complex mix of plant residues, microorganisms (living and dead) and the substrates produced by these organisms during decomposition. The soils organic matter influences the chemical, biological, and physical properties of soil in ways that are almost universally beneficial to crop production, such as promoting soil water infiltration and retention, nutrient availability, and the promotion of microbial biomass.

Soils are alive and teaming with microorganisms. In just one teaspoon of agricultural soil there can be one hundred million to one billion bacteria, six to nine feet of fungal strands put end to end, several thousand flagellates and amoeba, one to several hundred ciliates, hundreds of nematodes, up to one hundred tiny soil insects, and five or more earthworms. These organisms are essential for healthy growth of plants. For example, bacteria and fungi excretions help to form soil aggregates and provide food for other organisms via decomposition. Plants are the carbon producers of the world converting CO_2 to sugars via photosynthesis. While we are usually focused on the aboveground conversion of these sugars to biomass and crop yield, much of this carbon will remain in the system after harvest as crop residues and rhizodeposition. For example, up to 40% of the carbon fixed by plants is transferred to the soil rhizosphere (Lynch and Whipps 1990).

With the above in mind, one important question of agricultural management systems becomes how can we maximize soil health and carbon sequestration to promote maximum crop productivity in a sustainable and cost-effective manner? In this study we explore the influence of cropping intensity on the soil health properties of microbial biomass and soil organic carbon (SOC) after 24 years in no-till by analyzing soils from a long-term dryland cropping system project in eastern Colorado across three potential ET gradients near Sterling, Stratton and Walsh. Traditional practices in dryland agriculture of the semiarid Great Plains usually employ a wheat-fallow rotation. Fallowing land is frequently touted as a practical means to recharge soil water and promote subsequent crop yields. However, given the importance of plant C inputs to the soil and its role in soil health the question remains if this practice is sustainable over the long-term.

Materials and Methods

Site Descriptions

This study was conducted within a long-term sustainable dryland agroecosystems management project, which was initiated in 1985 in eastern Colorado to evaluate the effects of cropping intensity on production, water use efficiency and other selected soil chemical and physical properties (Peterson et al., 1993). This experiment has three major variables, 1) PET gradient, 2) topography (slope position), and 3) cropping intensity under no-till management. Soils at each site had been under conventional tillage crop-fallow management for over 50 years prior to the initiation of this study in 1985. The three sites represent an increasing PET gradient from north to south, but all have a long-term mean annual precipitation of 420 mm. The northern site at Sterling (40^0 22' 12"N, 103^0 7'48" W) has a deficit water (precipitation - open pan evaporation (OPE)) of 1140 mm yr^{-1}. The medium site at Stratton ($39^0$10'48"N, $102^0$15'36" W) has a deficit water of 1290 mm yr^{-1}. The southern site is at Walsh ($37^0$13'48"N, $102^0$10'12"W) with deficit water of 1555 mm yr^{-1}. The Sterling and Stratton sites represent approximately 73% and 83% of the relative PET respectively compared to the Walsh site (Peterson et al., 1998). The relative PET gradient is represented as low, medium and high for Sterling, Stratton and Walsh sites respectively.

Cropping systems representing a gradient of cropping intensities were placed across the soil sequences at each site in strips that were 6.1 m wide by 185 to 300 m long, depending on site. All phases (entry points) of each cropping system are present at each site every year accounting for a total of 11 treatments including a perennial native grass treatment. For example, WF cropping system requires two experimental units; one for wheat-fallow and the other for fallow-wheat in each of the two field replications. Cropping systems are: wheat (*Triticum aestivum* L.) - fallow (WF), wheat-corn (*Zea mays* L.)-fallow (WCF), wheat-corn-millet (*Panicum miliaceum*)-fallow (WCMF), and continuous cropping (CC) which included corn/sorghum [*Sorghum bicolor* (L.) Moench], wheat, hay millet and sunflower *(Helianthus annuus)* in order of frequency. The cropping system gradient is as follows: WF has an intensity factor of 0.50 (crops divided by yr in the rotation) and WCF, WCMF, and CC are 0.67, 0.75, and 1.0 respectively. A perennial grass treatment (G) also was established in the spring of 1986 with a seed mixture containing equal seed numbers of crested wheatgrass (*Agropyron cristatum* (L.) Gaertn., western wheatgrass (*Agropyron smithii* Rydb.), sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), little bluestem *(Schizachyrium scoparium* (Michx.) Nash), blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.), and buffalograss (*Buchloe dactyloides*).

Wheat Yields

Winter wheat yields were obtained within each PET site and slope and cropping system each year by harvesting with a small plot combine. A sub-sample of grain was taken to measure moisture and test weight. All yields are corrected for harvest moisture and presented based on market moisture of 12 percent. Only the first 12 years of the study is presented here as we wanted to compare more intensive rotations to WF as after the 12 year WF treatments dropped from the study. Yield data was averaged over slope positions and presented by PET site and cropping system.

Soil Carbon

Soil cores were taken to 10 cm depth from each treatment at all three sites and at all three slopes in the fall of 2009 after 24 years in no-till management. Cores were partitioned into 0-5, and 5-10 cm depth increments. Fifteen 2.54 cm diameter soil cores were obtained from each treatment combination and composited by depth. All visible plan material (roots, stems or leaves) larger than 2mm was removed and surface residue also was excluded from the samples. Soils were air dried and ground to pass a 2-mm sieve. A sub-sample of 20 to 25 grams was powder ground with a steel ball-mill grinder to pass through an 80 mesh sieve and analyzed for total C with dry combustion using a Leco True Spec CN auto analyzer (Leco, St. Joseph, MI) from a 0.2 g sub-sample. Carbonates were determined by using a modified pressure calcimeter method (Sherrod et al., 2002), and inorganic C was then subtracted from total C by dry combustion for determination of SOC. Two bulk density measurements were made per experimental unit at the time of soil sampling using a 5.36 cm diameter double-cylinder core sampler in 0-5 and 5 to 10 cm depth increments (Grossmand and Reinsch, 2002). The average of the two bulk density numbers were used to calculate soil C mass for the various pools (Table 2). Carbon concentrations were converted to mass using the following formula:

$$\text{kg ha}^{-1} = \text{ug C g}^{-1} \text{ x g soil cm}^{-3} \text{ x (depth increment in cm/10)}$$

Each depth increment mass for all C fractions was then summed for a depth of 10 cm.

The particulate organic matter C (POM-C) was determined by dispersing a 25-g sub-sample with 40-mL of sodium hexametaphosphate (5 g L^{-1}) and shaking on a reciprocating shaker overnight (Gregorich and Ellert, 1993; Cambardella and Elliott, 1992). The soil suspension was then poured over a 53um screen and all the material retained on this screen (sand and POM) dried overnight at 60 ^{o}C. The sand and POM fraction was then placed in glass jars with metal rods placed on a roller table to powder grind the sample. Both total and inorganic C was measured in this using a LECO Ture Spec CN analyzer and a modified pressure calcimeter method (Sherrod, et al., 2002) where organic C was calculated as total C from dry combustion minus inorganic C.

Soil Biology

To characterize the soil microbial community, 0.5g soil samples (air-dried, ground and stored at 22 ^{o}C) were analyzed. Total DNA was extracted from each sample using the MoBio power soil DNA isolation kit (Mo Bio, Carlsbad, CA) according to the manufacturer's instructions. Quantitative PCR (qPCR) amplification of the bacterial 16S rRNA genes (V1-V3 hypervariable region) was performed with the 27F and 388R primers (Lane et al. 1985; Marchesi et al. 1998). Each reaction contained 2 µl template DNA (diluted 1:20), 0.5 µM of each primer, and 1X Maxima SYBRgreen master mix (cat # K0242, Thermo-Fisher Scientific); amplification was performed as follows: 1) 95 ^{o}C for 8.5 min, 2) 95 ^{o}C × 15 sec, 58 ^{o}C × 30 sec, 72 ^{o}C × 60 sec, repeated 35 times, 3) 72 ^{o}C × 5 min. Genomic DNA isolated from *Pseudomonas putida* KT2440 was used as an external standard in order to calculate 16S rRNA copies per g soil FW extracted assuming a *P. putida* genome size of 3.174 fg and seven 16S rRNA copies per genome. qPCR efficiency was 93% and could detect as little as 100 *P. putida* genomes in a single PCR reaction.

Amplified DNA samples were then pooled in equimolar ratios to create a single bacterial DNA library; the pooled library was re-quantified using the KAPA Biosystems qPCR kits and subjected to pyrosequencing at four copies per bead with the Roche GS Junior Sequencing

System (Branford, Connecticut). All sequencing read editing and processing was performed using previously described methods (Manter et al. 2010). After processing, each 16S library rarefied to 1000 sequence reads in order to standardize sampling effort for each sample. The abundance of previously identified beneficial bacteria genes, nitrogen-fixation (*nifD*, *nifH*), plant root elongation (*acdS*, *ipdC*), plant disease suppression (*budC*, *chit*, *hcnA*), and nutrient acquisition (*ppqA*, *entF*, *iucC*) in each 16S library was predicted using PiCRUSt (Langille et al. 2013). Total gene-specific abundance (copies g^{-1} soil FW) was calculated as the product of the relative abundance and the total 16S copies (copies g^{-1} soil FW) determine from the initial sample qPCR.

Results

Wheat yields under the two higher cropping intensity treatments with a wheat phase (WCF and WCMF) were compared to the business-as-usual treatment of WF (Fig 1). Although significant annual variation in yields were observed for all treatments, wheat yields typically increased with cropping intensity. For example, yields were higher in the WCF and WCMF 16 and 25 times out of a possible 36 (i.e., 12 years x 3 sites) respectively. Over the entire 12 year period, yield gains were greater than losses and the average increase in yield over the 12 years period was 8.6% (WCF) and 12.1% (WCMF) relative to the WF treatment.

All soil carbon pools significantly increased with cropping intensity. After 24 years of increased cropping intensity, soil POM increased significantly in all treatments relative to the traditional WF system (Fig 2). At all sites, the largest gains were observed in the grass system with lower, but significant, gains in the WCF and CC treatments. A similar trend in microbial biomass was observed for all sites and treatments, with the largest gains in the high ET potential site. For example, bacterial biomass increased by 149, 197, and 1022 % in the WCF treatment at Sterling, Stratton and Walsh, respectively. A highly significant correlation between soil POM and bacteria (r = 0.890) or fungal (r=-0.777) biomass was observed across all sites and treatments.

The composition of the bacterial soil communities, determined by pyrosequencing, showed that community composition (i.e., species present) differed significantly between site and cropping intensity (data not shown). On a relative abundance basis, the variance in community composition was best explained by site (30.3%), cropping intensity (17.0%), and slope position (1.2%). However, identification of the abundance of several beneficial bacterial genes showed that despite these taxonomic differences, cropping intensity had the largest influence on the abundance of beneficial bacteria (Fig 4). All of the beneficial bacteria quantified (i.e., N-fixation, P-solubility, biocontrol, root growth, and nutrient acquisition) increased significantly with cropping intensity. Interestingly, at the high ET potential site (Walsh), bacteria associated with root-growth had the greatest increases, increasing 3677% (CRP vs WF), as compared to 545 and 400% for Stratton and Sterling, respectively.

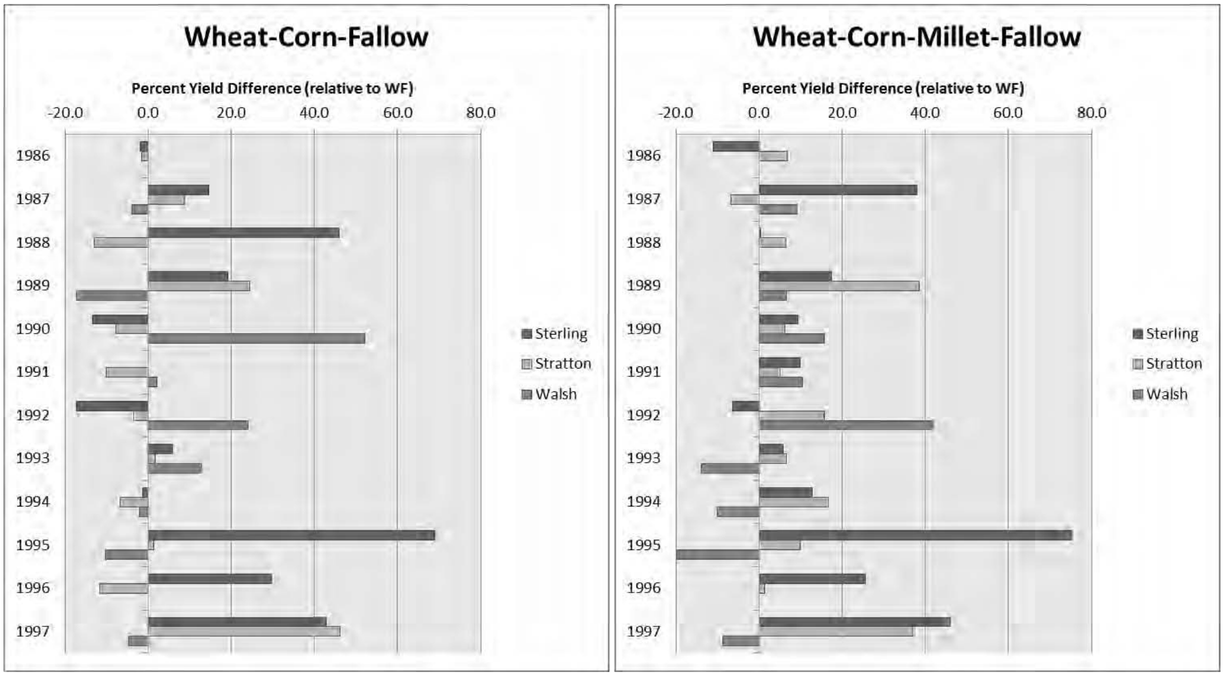

Figure 1. Yield in response to cropping intensity. Bars represent the percent increase in wheat yields for the WCF and WCMF relative to WF for each of three sites in eastern Colorado.

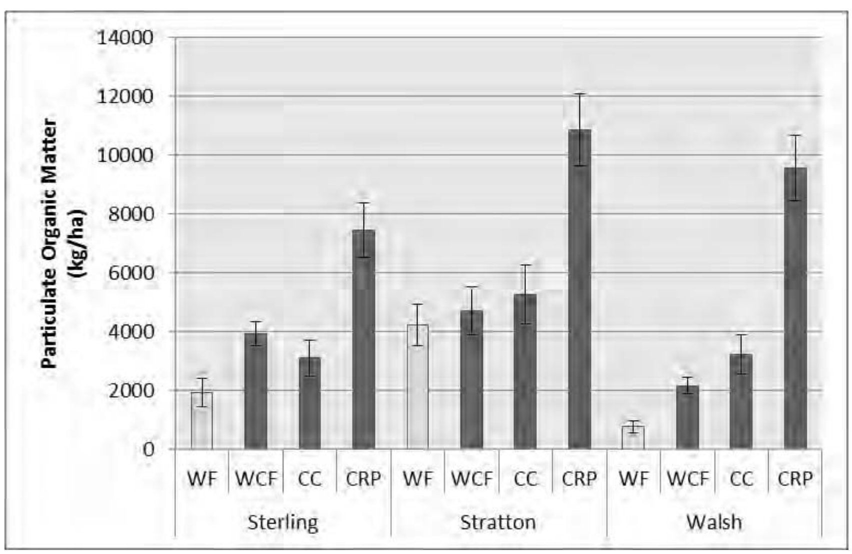

Figure 2. Particulate organic matter C (POM-C) in response to cropping intensity. White bars (1986) and gray bars (2009).

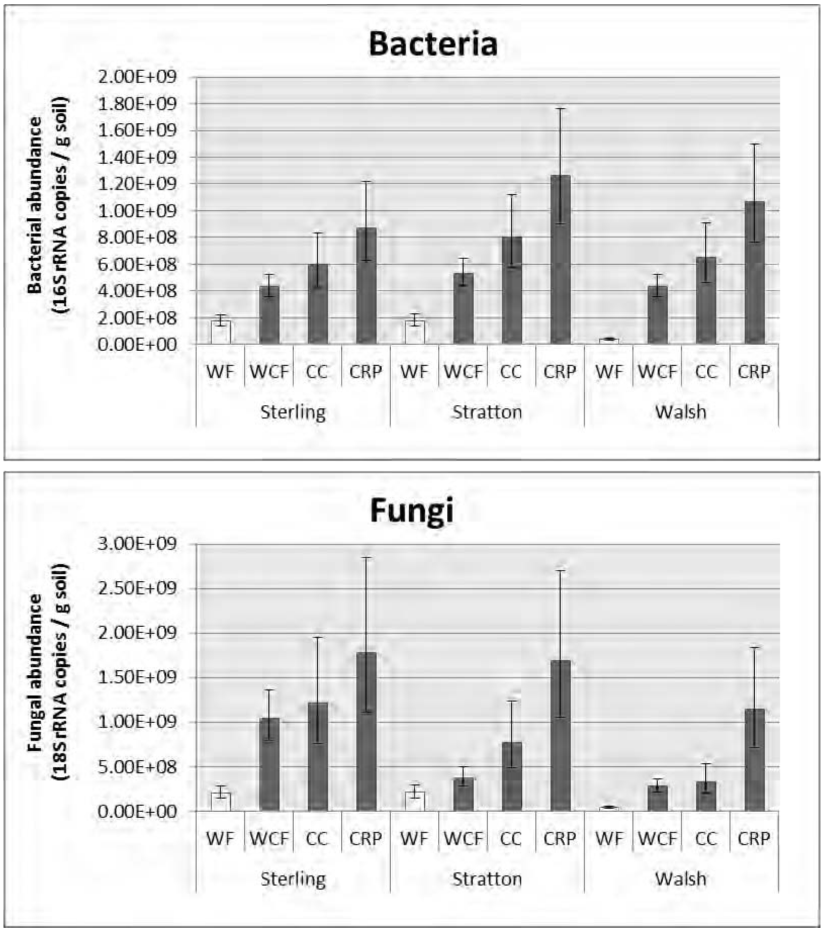

Figure 3. Soil microbial abundance in response to cropping intensity.
White bars (1986) and gray bars (2009).

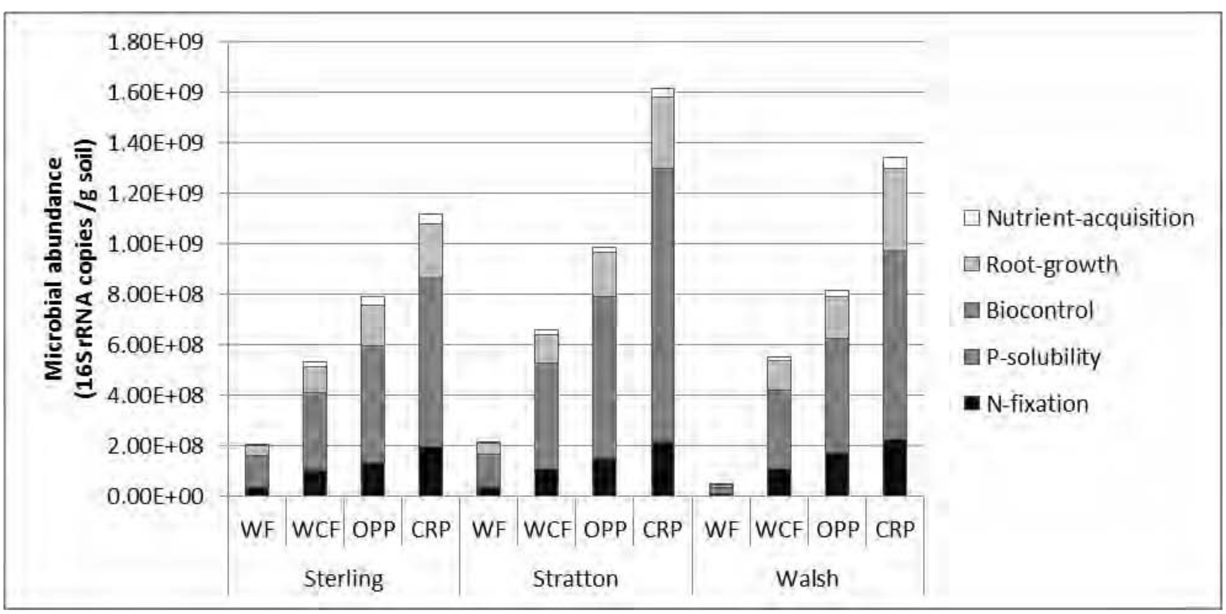

Figure 4. Soil microbial abundance in response to cropping intensity.

Discussion

In this report, we have focused on the impact of cropping intensity on soil C and microbial community structure in a 24 year long-term study in three dryland sites of eastern Colorado. At all three sites, significant gains in soil C and microbial biomass were observed. Perhaps most importantly, the reduction in fallow frequency did not reduce wheat yields and average yields increased (WCMF vs WF) by 18.6, 12.0, and 3.5% for the Sterling, Stratton, and Walsh sites over the first 12 years. A similar analysis, could not be conducted for the second 12 years of the study since the WF treatment was removed from the study.

Fallow is often touted as being beneficial for crop yields due to its potential to reduce ET and increase soil water available to subsequent wheat crops. However, at all three sites studied here, we observed an overall increase in wheat yields as fallow frequency was reduced. Consistent with the availability of soil water, the observed increases were highest in the low ET potential site (Sterling) and lowest at the high ET potential site (Walsh). We suggest that the gains in wheat yield can be traced to an overall increase in soil health driven by the accumulation of soil C and beneficial microbes under increasing cropping intensity.

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Managing Soil pH Highs and Lows

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Soil pH is usually higher in regions where the potential evapotranspiration is higher than rainfall. These conditions are naturally found in western regions of Kansas with less than roughly 20 inches of precipitation per year. Minimal leaching of cations like Ca^{+2}, Mg^{+2}, K^{+}, and Na^{+} from the soil contributes to the high pH. However, the use of chemical fertilizers and other factors like organic matter decomposition can contribute to a significant decrease in soil pH creating areas of low pH particularly in the soil surface in the case of no-till system.

One common characteristic of alkaline soils is the accumulation of calcium carbonate (free lime) that is known as calcareous soils (Figure 1). These conditions of carbonate presence in the soil can generate severe micronutrient deficiencies and are usually noticeable in areas where the topsoil has been eroded or removed for leveling.

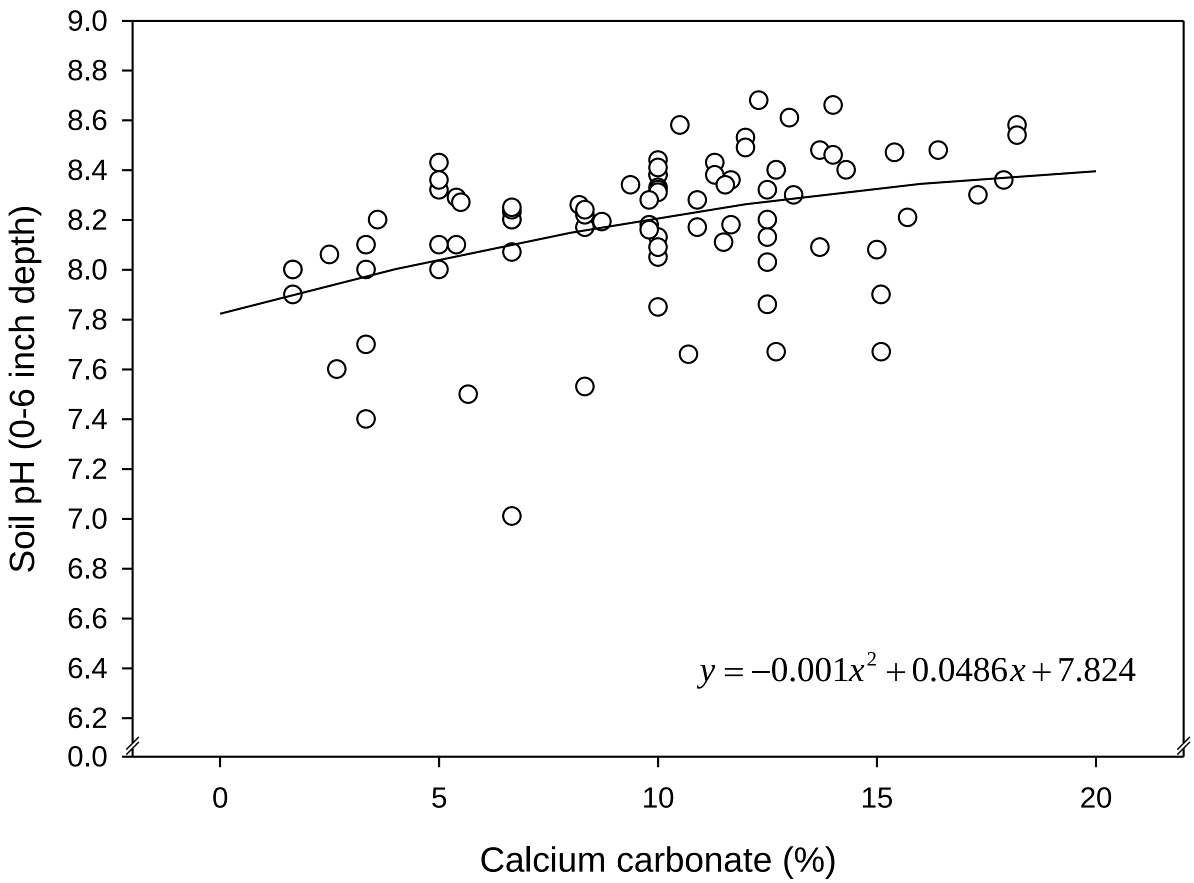

Figure 1. Soil pH and calcium carbonate (free lime) at the 0-6 inch depth.

The availability of most nutrients are influenced by soil pH. Metallic micronutrients like zinc, iron, copper, and manganese are usually highly available in acid soils. However the solubility of these nutrients is significantly lower in alkaline soils. Perhaps the most common nutrient deficiency found in alkaline soils is iron deficiency. Calcareous soils may contain high levels of total Fe, but in forms unavailable to plants. The solubility of this nutrient as determined by extractable DTPA-Fe is significantly lower at high pH values (Figure 2). Significant limitation in plant growth is common in crops like soybean and sorghum due to iron deficiency. Iron is usually considerably less soluble than Zn or Mn in soils with a pH value of 8 or more. Therefore, inorganic Fe contributes relatively little to the Fe nutrition of plants in calcareous soils, and most of the soluble Fe in the soil is complexed by natural organic compounds, making organic matter the main source of iron for crop uptake under this condition.

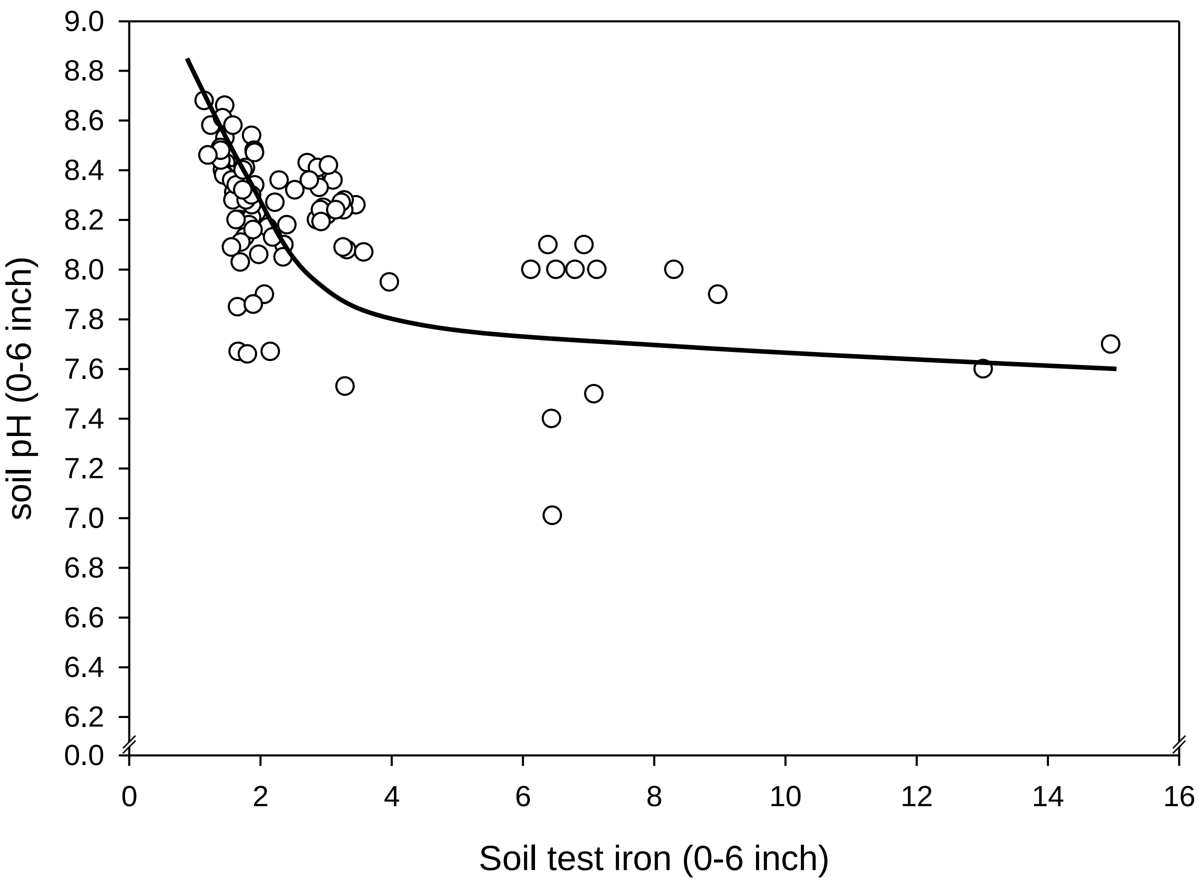

Figure 2. Soil pH and extractable DTPA iron (Fe) under alkaline soils conditions.

In areas with high levels of calcium carbonate (calcareous soils) the solubility of some nutrients (particularly micronutrients) can be significantly reduced, generating severe nutrient deficiencies (Figure 3).

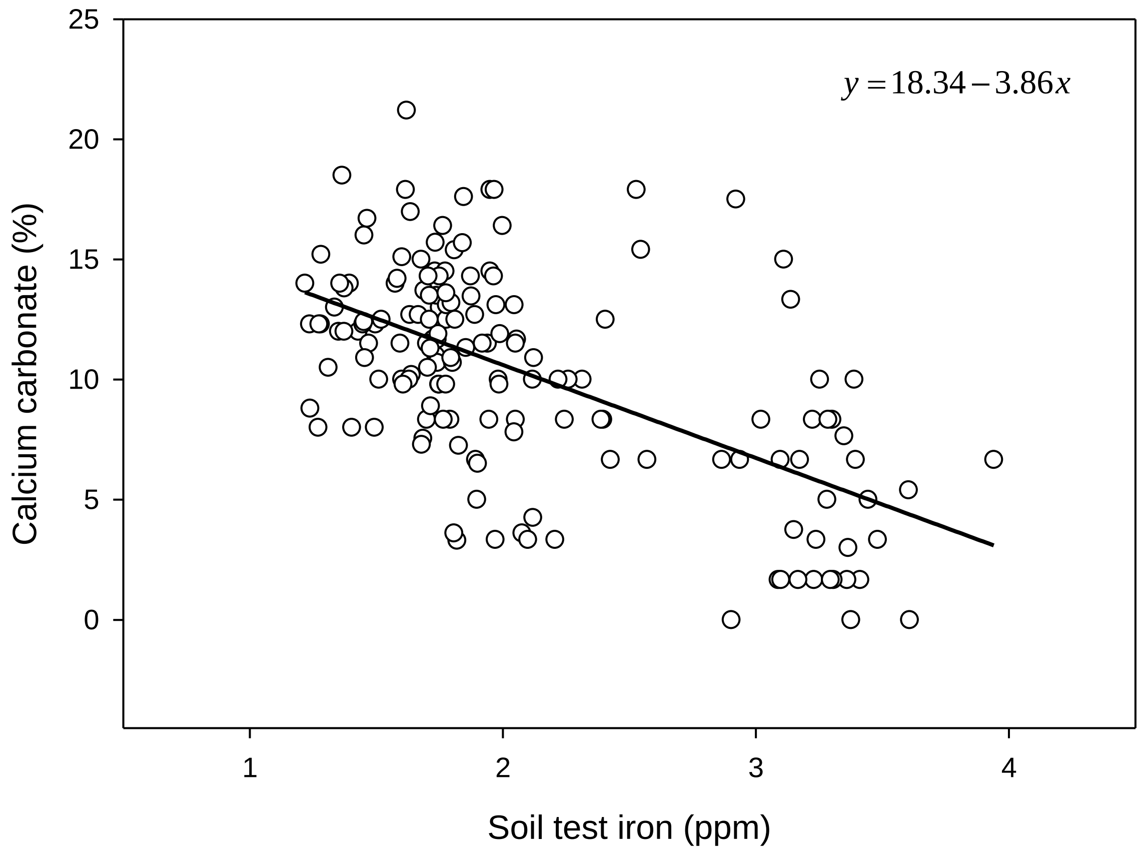

Figure 3. Effect of free calcium carbonate on extractable soil iron.

Under alkaline conditions, macronutrients like phosphorus would be associated primarily with calcium to form calcium phosphate. However, these calcium phosphates can be easily attacked by acids including organic acids excreted by plant roots to release phosphorus for uptake. The high-pH, calcium-rich conditions of alkaline soils may require special considerations for fertility management particularly of micronutrients. The solubility of soil-applied nutrients like iron can be reduced significantly shortly after application and before plant uptake. In-furrow application, in direct contact with the seed is particularly important for plant uptake under alkaline or calcareous soil conditions.

Low soil pH with long term NT system

One concern with long term NT with N application in the surface is the development of low soil pH in the surface. This condition and the need for lime application may require further evaluations. Typically low soil pH near the surface often go along with high OM in long term NT system (Figure 4). And higher OM content can help reduce soluble Al (Figure 5). Therefore, the potential plant response to lime application may be lower, however studies are needed to determine if this is true and how much lowers soil pH values should get to justify lime applications when compared to conventional tillage systems. But higher soil OM, and lower soluble Al should provide better growing conditions for plant roots.

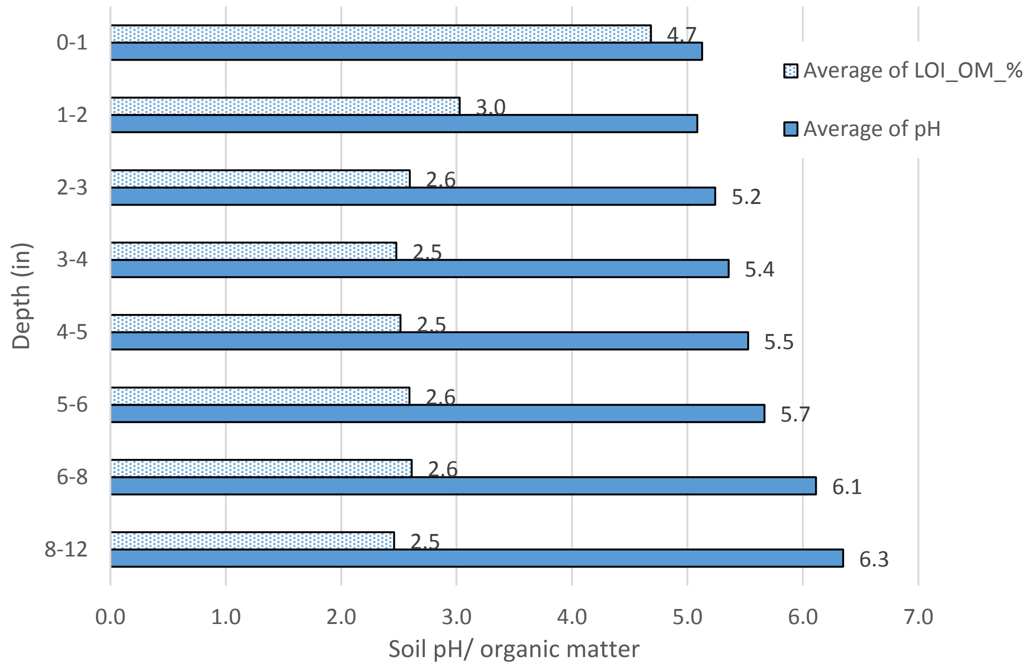

Figure 4. Soil pH and OM stratification with long term NT (~20 years).

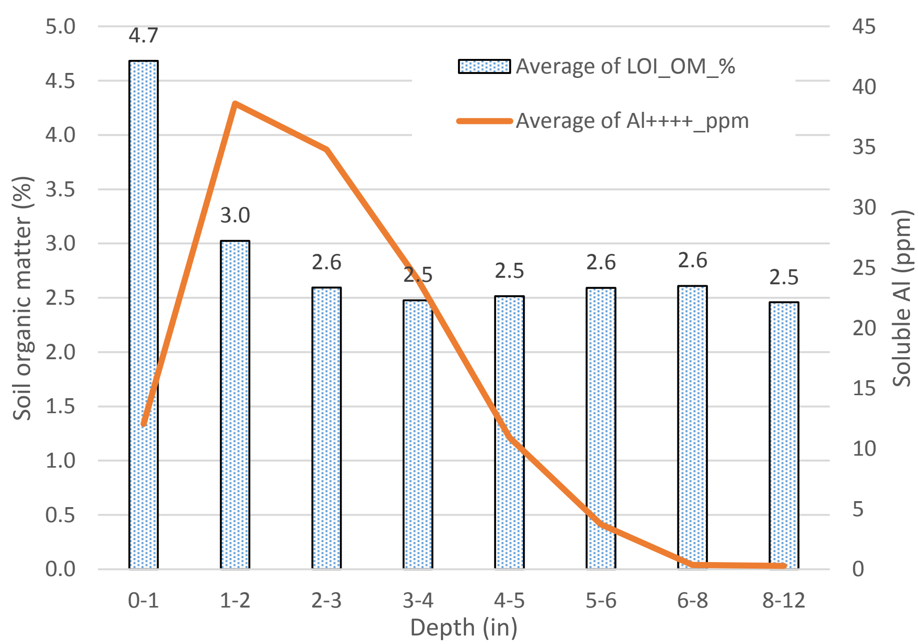

Figure 5. Soil OM and soluble Al. High OM help reduce soluble Al in the soil.

Scouting Sugarcane Aphids

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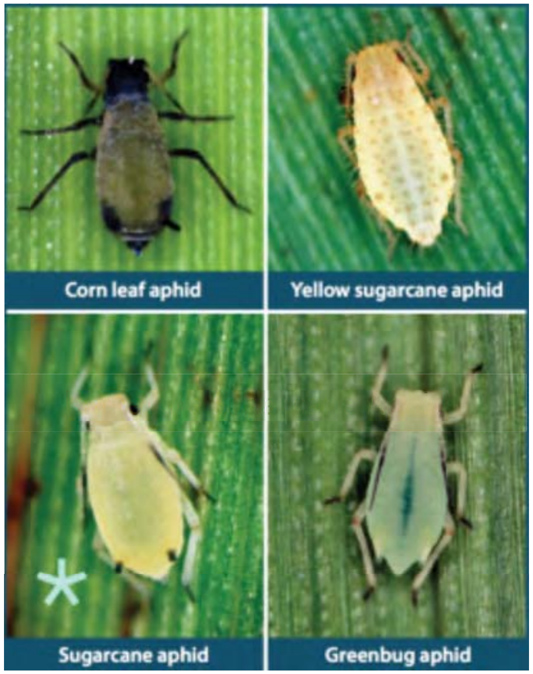
www.myfields.info

K-STATE Research and Extension

Adult Sugarcane Aphid (*)



Winged Adult

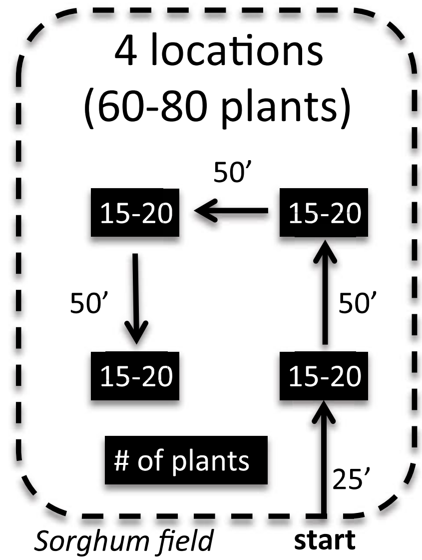
Information adapted from NTO-043, Bowling et al. (2015)

Timing effective treatment to control ***sugarcane aphids*** (SCA) in sorghum depends on the size of the SCA population. To estimate the number of SCA in a field, follow these steps for scouting the field and use the **Sampling Protocol** (**below**) and % plants with honeydew (**on back**) to make treatment decisions.

First Detection: Is the Field at Risk?

Once a week, walk 25 feet into the field and examine plants along 50 feet of row (see right):

- If honeydew is present, look for SCA on the underside of a leaf above the honeydew.
- Inspect the underside of leaves from the upper and lower canopy from 15–20 plants per location.
- Sample each side of the field as well as sites near Johnsongrass and tall mutant plants.
- Check at least 4 locations per field for a total of 60–80 plants.



NOT Present?

If **no** SCA are present, or only a few wingless/winged aphids are on upper leaves, continue once-a-week scouting (**protocol above**).

or

Present?

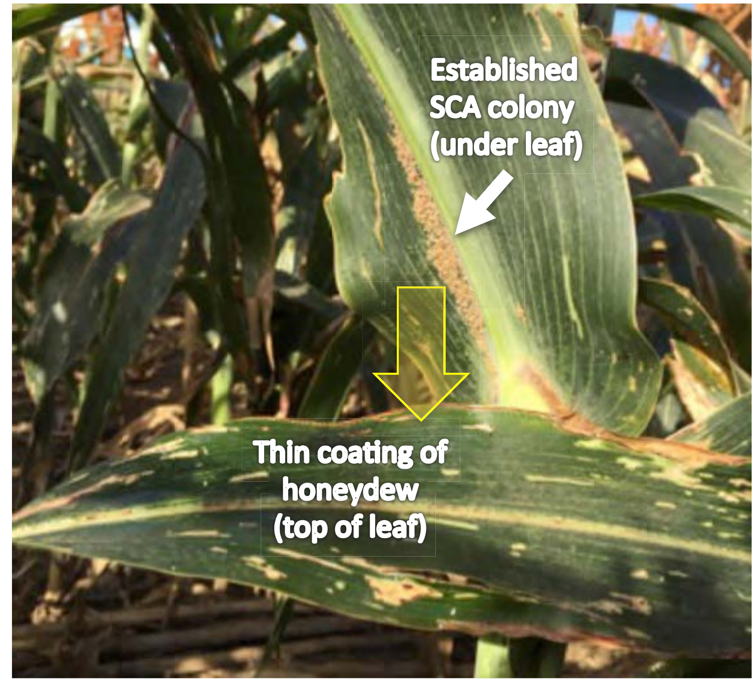
If SCA **are** found on lower or mid-canopy leaves, begin twice-a-week scouting. Use the Sampling Protocol (**above**) and % plants with honeydew (**on back**).

SCA Threshold by Growth Stage

Estimate the percentage (%) of infested plants with large amounts of sugarcane aphid (SCA) honeydew (see right) to help time foliar insecticides for SCA control on sorghum.

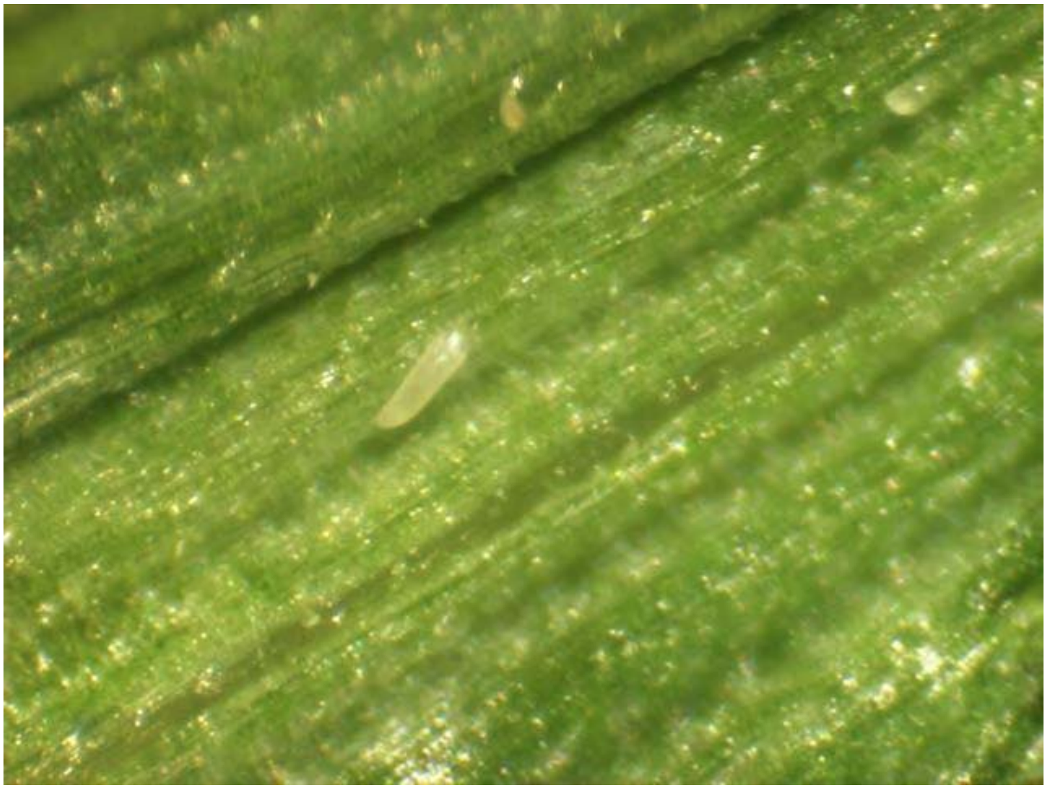
Growth Stage	Threshold
Pre-Boot	20% plants infested with localized area of heavy honeydew and established aphid colonies
Boot	20% plants infested with localized area of heavy honeydew and established aphid colonies
Soft Dough	30% plants infested with localized area of heavy honeydew and established aphid colonies
Dough	30% plants infested with localized area of heavy honeydew and established aphid colonies
Black Layer	Heavy Honeydew and established aphid colonies in head *only treat to prevent harvest problems **observe Preharvest intervals

Table courtesy of Angus Catchot at Mississippi State University

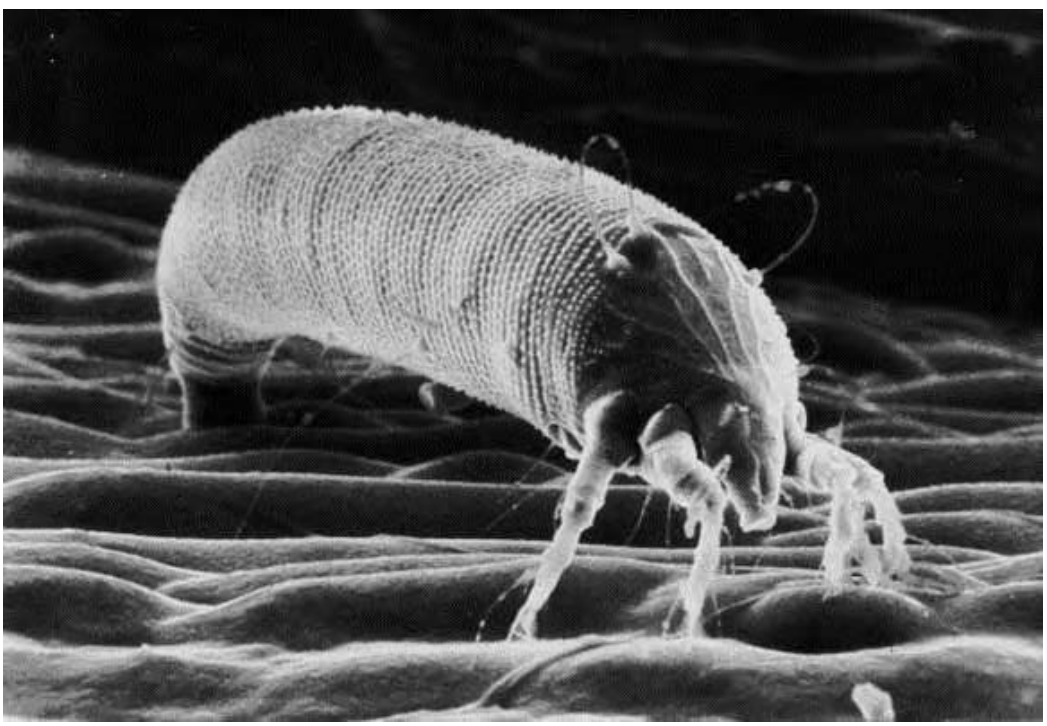


Learn more about sugarcane aphids at:
http://myfields.info/pests/sugarcane-aphid

Wheat Curl Mite, *Aceria tosichella*.



Wheat curl mite on leaf.



Close-up of wheat curl mite (SEM).

Introduction

The wheat curl mite is widely distributed in North America. These tiny Eriophyid mites are important vectors of wheat streak mosaic virus (WSMV) which is one of the most destructive wheat diseases in western Kansas. They are also vectors of the High Plains Virus, a disease of wheat and corn in the Great Plains, and Triticum Mosaic Virus (TrMV). Combined infections of WSMV and TrMV can be especially damaging in wheat.

Life History

Adult and immature wheat curl mites are tiny, white, cigar-shaped organisms with four legs near the head. They are nearly invisible to the naked eye and fit between the veins of the wheat leaves. Eggs are placed in rows along leaf veins. The mites reproduce most rapidly at 75° to 85°F. Reproduction stops at temperatures near freezing, but the mites can survive for several months at near freezing temperatures and for several days at 0°F. Under good conditions, a generation can be completed in 10 days. Most mites are found on the terminal leaves and move to each new leaf as it emerges. Heavy mite populations can cause the leaf margins to role or curl inward hence the name. As the wheat plant dries down, the wheat curl mites congregate on the flag leaves and even the glumes of the head where they are picked up by wind currents and carried to their over -summering grass hosts including volunteer wheat, corn and a few other grasses. As summer hosts start to dry down the reverse process occurs and mites are carried by winds to newly emerged winter wheat. Hail during the heading period can lead to high oversummering populations by knocking heads containing wheat curl mites to the ground and starting early volunteer. This early volunteer can then be immediately infested with wheat curl mites.

Management Practices

Destruction of volunteer wheat at least 2 weeks prior to planting winter wheat in the fall is the most effective management practice for this mite and the disease that it vectors. Avoiding early planting can also reduce wheat curl mite numbers and the length of time that they have to transmit wheat streak. Varietal selection can also be an important way to reduce the impact of wheat streak. Producers in areas where wheat streak is common should avoid varieties that are highly susceptible to WSMV. The KSU cultivar RonL is a white wheat that carries a high level of resistance to WSMV provided it is not exposed to extremely high temperatures in vegetative growth stages. Thus, RonL should be planted mid-season to ensure its resistance is not compromised by high temperatures that may occur in either early fall or late spring. Additional information on varietal susceptibility to wheat streak is available in KSRE publication MF-991: Wheat Variety Disease and Insect Ratings. To date, control of wheat curl mites with foliar miticides has not been shown to be an effective practice.

P. E. Sloderbeck, J.P. Michaud, and Robert J. Whitworth -- May 2008

Page last updated 10/30/2013 by J.P. Michaud.

Wheat Stem Sawfly

History

The wheat stem sawfly, *Cephus cinctus* Norton (Hymenoptera: Cephidae), is a herbivorous wasp that attacks a number of native grass species in North America. It was first reported attacking wheat in Canada in 1896 and soon spread to become a serious pest of spring wheat throughout the Dakotas, Montana, and Wyoming. The wheat stem sawfly has long been present in wild grass species over a much broader range, including Nebraska and Kansas, although neighboring wheat fields were unaffected.

Historically, only spring wheat was attacked. It was not until the 1980s that infestations were observed in winter wheat. By 1996, scientists working in Montana determined that the pest had evolved faster development and was emerging some 20 days earlier than it previously had, enabling it to survive in early-maturing winter wheat. Recent observations in Nebraska (2012) indicate that 50 percent of adults emerged by May 22, although this was a particularly early spring.

Collectively, research suggests that attacks on winter wheat may have been occurring for some time but went unnoticed because larvae did not complete development and cut stems. This may be the case in Kansas currently, with populations under strong selection to evolve faster development. It is not yet clear if recent winter wheat infestations in the Nebraska panhandle and northeastern Colorado result from local populations evolving to exploit winter wheat, or the southerly range expansion of an adapted strain. Local populations express significant variation in biology, behavior, and genetics that suggest regional adaptations. Presently, Kansas is on the southeastern boundary of the region experiencing wheat stem sawfly problems in winter wheat.

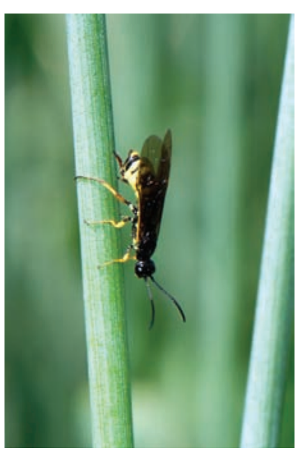


Figure 1. Adult wheat stem sawflies mating (above)

Figure 2. Female wasp ovipositing (right)

Identification

The adult wasp is about half an inch long with a black body and three broad, transverse yellow bands on the abdomen. Legs are yellow and wings are a dark, smoky grey. Females are significantly larger than males (Figure 1) with a short, curved ovipositor that is externally visible (Figure 2). Eggs are whitish and elongate, difficult to observe, and usually laid in the uppermost portions of the stem (Figure 3). Larvae are initially colorless (Figure 4), soon turning cream-colored with a dark head capsule; they feed inside stems, moving to the base of the plant as they mature. Infested stems typically contain abundant frass that looks like sawdust, and larvae wriggle into a characteristic S-shape when removed (Figure 5). Another insect commonly occurring in wheat stems is the wheat stem maggot, *Meromyza americana* Fitch. Its larvae are smaller and legless. Cleanly severed stems and stubble ends packed with frass (Figure 6) indicate the presence of wheat stem sawfly.

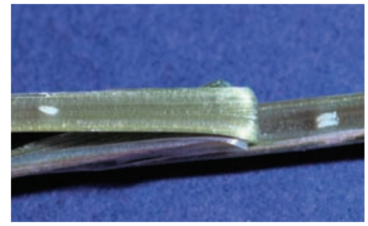


Figure 3. Eggs

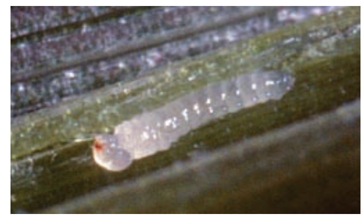


Figure 4. First instar larva

Figure 5. Mature larva in stem

Figure 6. Stubble cut by wheat stem sawflies

Biology and Behavior

The wheat stem sawfly has only one generation per year. Adults emerge from the previous year's stubble over a period of three to five weeks in spring. As with most insects, the emergence timetable is dictated by temperature and varies with latitude and among regional populations. Males emerge slightly ahead of females and mating takes place as soon as females emerge, unless severe weather delays activity. Adults do not feed and live only about a week, but each female emerges with a full complement of up to 50 eggs. Like many other wasps, mothers can control the sex of their offspring. Fertilized eggs develop into daughters and unfertilized eggs, into sons. Females are more sensitive to host plant quality than males because body size is correlated with stem diameter and larger females emerge with more eggs. Consequently, females tend to lay fertilized eggs in larger diameter stems.

Taller, more developmentally advanced, plants tend to be preferred for oviposition. There is a strong edge effect; field margins sustain higher infestation levels when wheat stem sawflys immigrate from adjacent fields. Notably, females do not avoid laying eggs in plants already infested, even though larvae cannibalize each other until only one remains, usually the first to hatch. Western wheatgrass is a preferred host among wild grasses; smooth brome and quackgrass are also infested. Emergence from wild grasses occurs later than emergence from wheat, so wild hosts do not appear to serve as a major source of wheat infestation and probably support a different host race. Barley is a poor host relative to wheat; rye and oats are accepted for oviposition but do not support complete larval development. Recent research has shown that specific volatile chemicals emitted by host plants influence the oviposition preferences of the female and account for differences in attractiveness among some wheat varieties.

After feeding for about a month and passing through five instars, mature larvae descend to the base of the plant where they may girdle the stem (Figure 7), plugging the lumen of the stem with frass and overwintering in a silken coccoon in the chamber beneath. Although stem cutting tends to be associated with drying of the wheat, the behavior is variable and may interact with other environmental factors. Stems are not cut unless larvae complete development; a significant proportion of stubs may be cut at, or just below, ground level, and some larvae may mature without cutting at all. Significant variation in cutting propensity exists among regional populations, and the proportion of infested plants that are cut can vary greatly from site to site and year to year. Complete development requires a

Figure 7. Cut stubble showing frass plug (left) and emergence hole (right)

90-day period of larval diapause under cold temperature conditions, followed by a pupation period that lasts up to three weeks. Pupation occurs within the stem (Figure 8) and adults emerge in mid to late spring. Although adults have been known to disperse as far as one mile, they are relatively weak fliers and tend to orient to the nearest suitable host plants.

Figure 8. Pupation occurs within the stem

Larval girdling severely weakens the stem and leads to plants that lodge easily when stressed by wind. The main economic impact of wheat stem sawfly is lodged plants that cannot be picked up by the combine, and reduced harvest efficiency as slower combine speeds are required to salvage girdled plants. In addition, larval feeding disrupts translocating tissues and diminishes the photosynthetic capacity of the plant during the critical period of grain fill, reducing test weight and protein content. Both kernel weight and the number of kernels per head are affected, reducing grain weight by 10 to 25 percent and protein content by around 1 percent. However, estimates of per-plant yield reduction may underestimate yield impact at field level because of the tendency of larger plants with greater yield potential to be preferentially infested. Shriveled and misshapen kernels are another indication of wheat stem sawfly infestation (Figure 9), but these symptoms also may have other causes.

Figure 9. Shriveled and misshapen kernels may indicate infestation

Management

Cultural Control

Various cultural tactics are essential components of an effective wheat stem sawfly management strategy. It is most important to avoid planting wheat continuously in the same field once the wasp has been detected as this can lead to a very rapid increase in populations. Non-host grains such as oats and rye can be planted as trap crop strips along field borders adjacent to last year's stubble. This approach can reduce infestation of wheat and decrease wheat stem sawfly populations, but is not effective when wheat stem sawfly is abundant or emerging from stubble within the same field.

Increasing wheat stem sawfly problems have been attributed to adoption of no-till practices that favor overwintering survival of immature stages. Thus, tillage has been suggested as a control tactic. Shallow tillage can be used to disturb and expose infested stubble on the surface, causing larvae within to either desiccate in summer or freeze in winter. Unfortunately, no-till is the most important means of soil moisture conservation on rain-fed acreage, so tillage is not an acceptable control tactic for this region. Additionally, tillage can yield inconsistent results in reducing adult wheat stem sawfly populations, because of its dependence on environmental factors to produce mortality. It also has negative impacts on beneficial parasitoids. Burning of stubble is also ineffective and associated with more negative (loss of organic matter) than positive impacts on the cropping system.

Work in North Dakota suggests that early swathing of wheat (once grain moisture drops below 40 percent) can be used to salvage yield and is usually recommended if infestation reaches or exceeds 15 percent of stems as the crop approaches maturity. Swathing requires investment in additional equipment and results in higher energy costs than direct combining. Sampling should be conducted at different places in the field — if the infestation is low, only field borders may need to be swathed. Swathing at a high cutting height (just below the heads) is recommended to help preserve beneficial parasitoids that pupate higher up in the stem.

Host plant resistance

Solid-stemmed (SS) wheat varieties have stems filled with pith to varying degrees. The SS trait presents mechanical resistance to boring larvae and has been effective in reducing both yield losses and local wheat stem sawfly populations. Early solid-stemmed varieties, such as 'Rescue' were developed in the 1950s and suffered from considerable yield drag, but more recently developed varieties have yield comparable with high-yielding, hollow-stemmed varieties. Newer solid-stemmed varieties include Choteau, released in 2003 from the Montana Agricultural Experiment Station; AC Lillian, released in 2006 from Agriculture Canada; and Mott released in 2009 from the North Dakota Agricultural Experiment Station. However, because expression of the SS trait interacts with environmental factors such as sunlight and temperature, cloudy and rainy weather can prevent the filling of the stem with pith and render solid-stemmed varieties more susceptible. Larvae in solid-stemmed plants have lower survival and less impact on yield, although they remain equally susceptible to parasitism. If wheat stem sawfly infestation reaches or exceeds 15 percent of plants, a solid-stemmed variety is recommended for planting in subsequent years. Although use of solid-stemmed varieties is currently a cornerstone of wheat stem sawfly management in the northern Great Plains, no such varieties have yet been developed for this region.

Chemical control

Insecticides are not recommended for wheat stem sawfly control for a variety of reasons. Wheat is a low-value crop grown on large acreage, making pesticide applications relatively expensive. Immature stages of the pest are all protected within the stem and trials indicate that seed treatments are ineffective, so treatments must target adults before eggs are laid. A number of insecticide labels claim to "aid in control of adults," but unfortunately, wheat stem sawfly adults emerge over an extended period and do not feed, substantially reducing their exposure. Adults must come into direct contact with an insecticide to be killed and are able to enter fields shortly after an insecticide application with minimal knockdown. Some insecticide trials timed sprays to target early, mid, and late emergence of wheat stem sawfly and found that as many as three applications of a pyrethroid insecticide only reduced infestation by half, a benefit that was far exceeded by application costs. In addition, pesticides will reduce populations of parasitoids and predators that will provide more cost effective natural control, even if it is not complete.

Biological control

Various natural enemies attack the wheat stem sawfly in its immature stages and help to suppress populations to varying degrees in different localities. The primary parasitoid of wheat stem sawfly larvae is the wasp *Bracon cephi* (Gahan), although *B. lissogaster* Muesebeck also contributes mortality in natural grassy areas. These wasps are ectoparasitoids that lay their eggs on wheat stem sawfly larvae within the stem (Figure 10), and then feed externally on their host. Although the parasitized larva feeds for some time, it does not survive to cut the stem and as a result, plant damage and yield impact are substantially diminished. Unlike the wheat stem sawfly, parasitoids have a second generation close to, or just after, wheat harvest and their effectiveness in different localities may partly depend on their ability to find alternative hosts for overwintering. Wheat should be harvested with a high cutting height (just below heads) to conserve parasitoids that pupate higher in wheat stems. Parasitoids have tracked infestations of wheat stem sawfly into Colorado and Nebraska, and they can be expected to contribute to mortality in Kansas, although no data is yet available.

Figure 10. Larva of Bracon cephi.

Author

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The author thanks Jeff Bradshaw for sharing current observations, Pat Beauzay and Robert Peterson for use of photographs, and Janet Knodel for reviewing the manuscript.

Photo credits

Figures 1, 3, 4, 5, 7, 8, 10: R.K.D. Peterson, Montana State University.

Figures 2, 6: Pat Beauzay, North Dakota State University

Figure. 9: Canadian Grain Commission

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF3089 **April 2013**

Kansas Farm Financial Overview – A Financial Crisis?

Gregg Ibendahl
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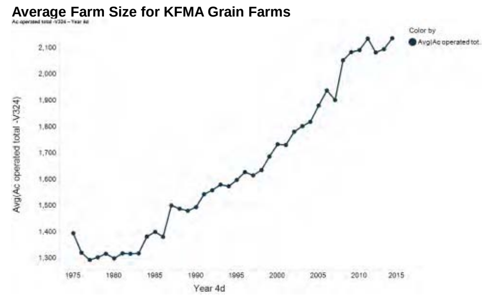
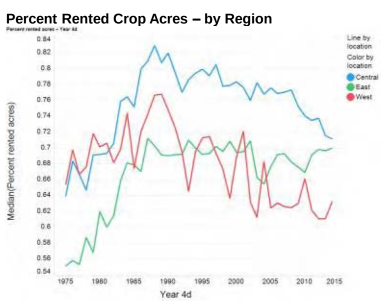
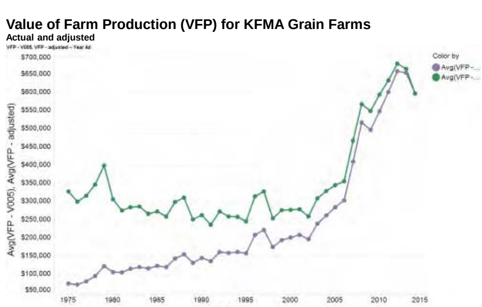


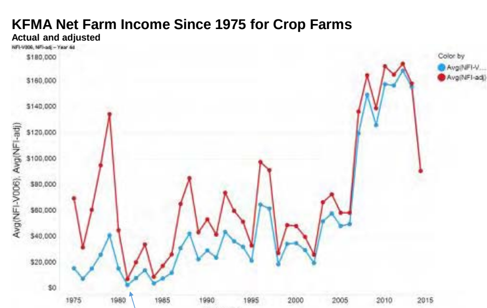


75% rented acres
= 3 rented acres to
1 owned acre

66% rented acres
= 2 rented acres to
1 owned acre

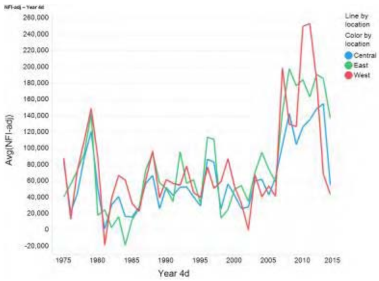
Income statement





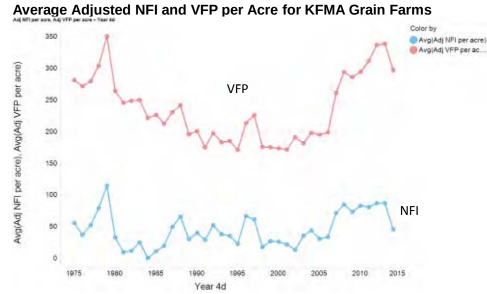
Low
point
for NFI

Average Adjusted Net Farm Income – by Region

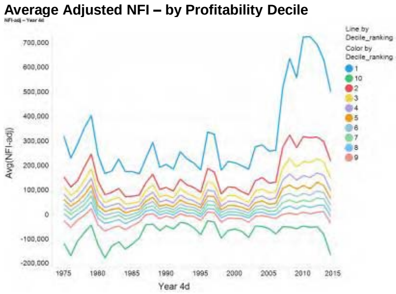


Big drop in NFI in 2013 and 2014 – Mirrors the period from 1980 and 1981

Average Adjusted NFI and VFP per Acre for KFMA Grain Farms



Average Adjusted NFI – by Profitability Decile

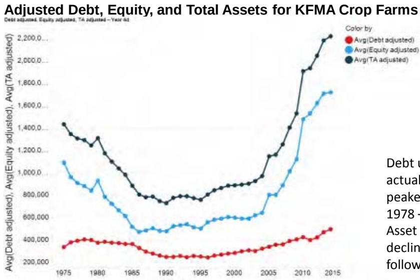


#9 – Usually breaks even

#10 – Typically shows a loss

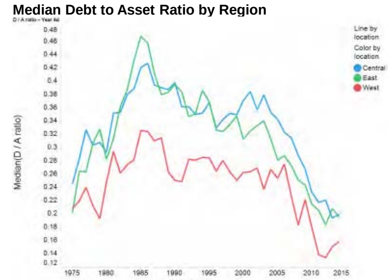
Balance sheet

Adjusted Debt, Equity, and Total Assets for KFMA Crop Farms



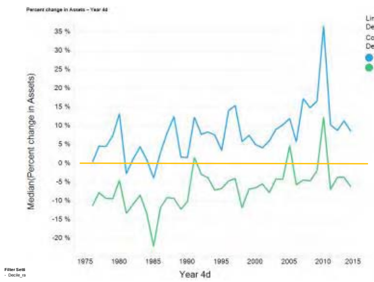
Debt use actually peaked in 1978 – Asset declines followed

Median Debt to Asset Ratio by Region



Debt-to-Asset ratio would appear to be a trailing indicator

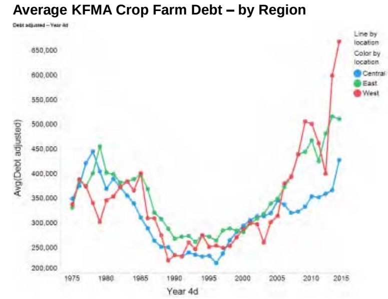
Yearly Percentage Change in Assets – Selected Profitability Groups



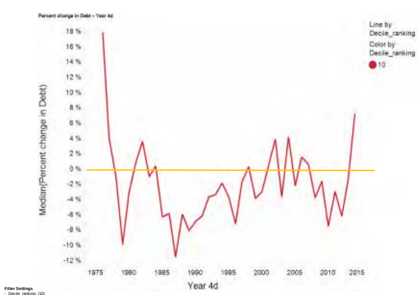
Any number above zero means Farm assets increased.

Any number below zero means farm assets decreased

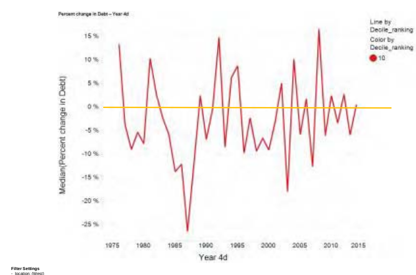
Average KFMA Crop Farm Debt – by Region



Yearly Percentage Change in Debt– Bottom Profitability Group



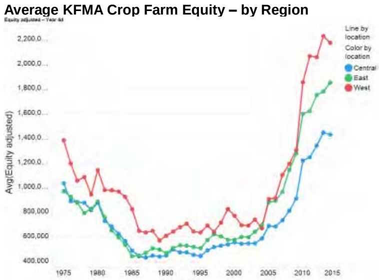
Yearly Percentage Change in Debt– Bottom Profitability Group – Western Kansas



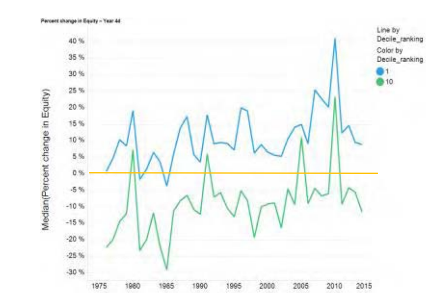
Why didn't Western KS add to it's debt last year?

Are farmer's credit lines tapped out?

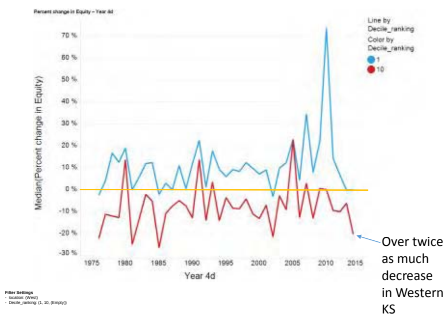
Average KFMA Crop Farm Equity – by Region



Yearly Percentage Change in Equity– Selected Profitability Groups



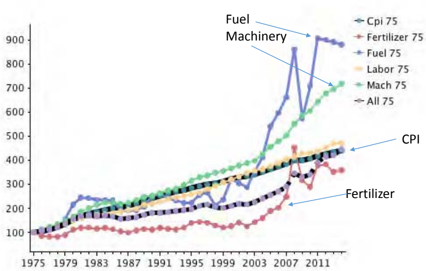
Yearly Percentage Change in Equity – Selected Profitability Groups – Western Kansas



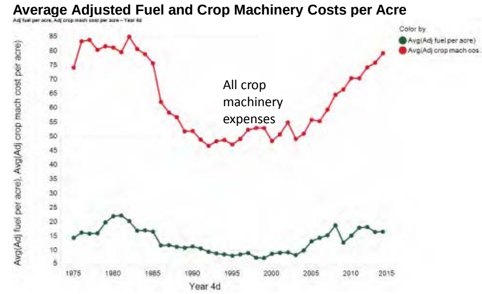
Specific expenses

USDA Input Price Indexes

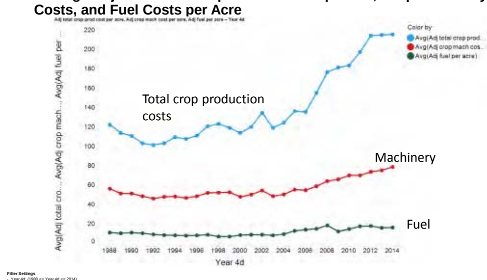
Normalized to 1975=100



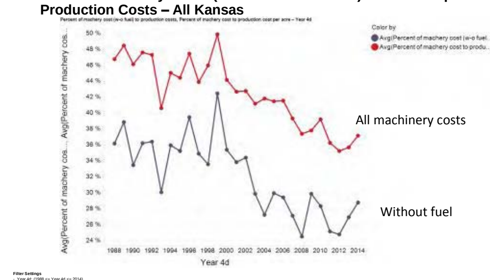
Average Adjusted Fuel and Crop Machinery Costs per Acre

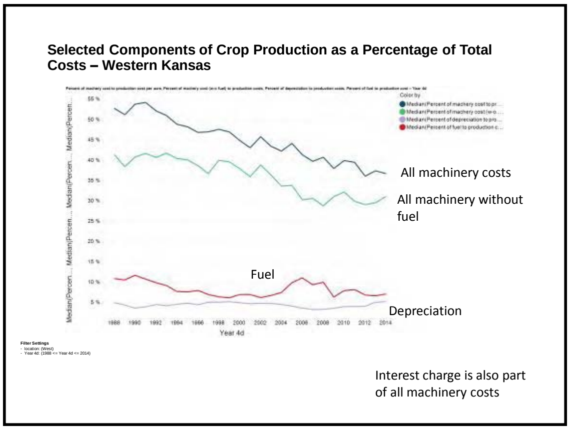


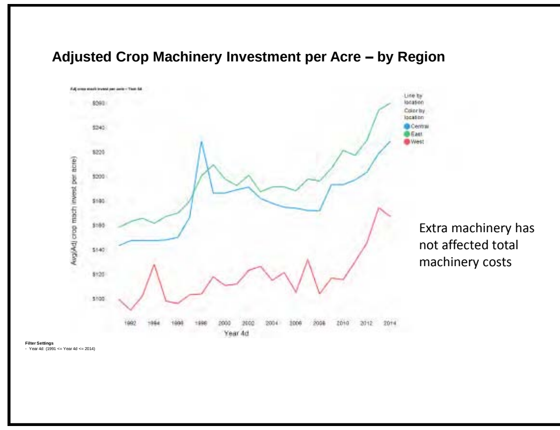
Average Adjusted Total Crop Production Expenses, Crop Machinery Costs, and Fuel Costs per Acre



Ratio of Machinery Costs (with and without fuel) to Total Crop Production Costs – All Kansas




Selected Components of Crop Production as a Percentage of Total Costs – Western Kansas
All machinery costs
All machinery without fuel
Fuel
Depreciation
Year 4d
Interest charge is also part of all machinery costs


Adjusted Crop Machinery Investment per Acre – by Region
Year 4d
Extra machinery has not affected total machinery costs

UAVs in Crop Production: FINE-TUNING CROPPING SYSTEMS VIA INTEGRATION OF NEW TECHNOLOGIES

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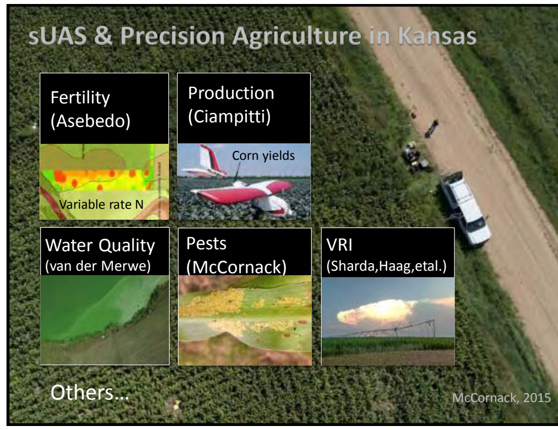
@KSUCROPS (TWITTER)

K-STATE Research and Extension — Crop Production Team — KSUCROPS — Kansas State University



Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Presentation Outline: sUAVS

sUAVS (unmanned aircraft vehicle systems)

- Difference between Hex vs. Fixed Wing (Plane)
- Scalability Issue/ Imaging Processing Step
- Agronomic Application for multiple crops
  - Scouting and Diagnosing Purposes
    1) Weed Identification
    2) Biomass and Grain Estimation
    3) On-farm production problems
    4) Herbicide Drift
    5) Crop Re-Planting Tool
    6) Detection of Plant Height
    7) Phenotyping for stresses
    8) Pest Surveillance

Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

sUAVS: Difference between Hex vs. Plane

Hex

KSU DJI S800 Spreading Wings hexacopter. Collect low altitude (~325 ft yielding pixel size of ~ 0.5 in.) pics.

Plane

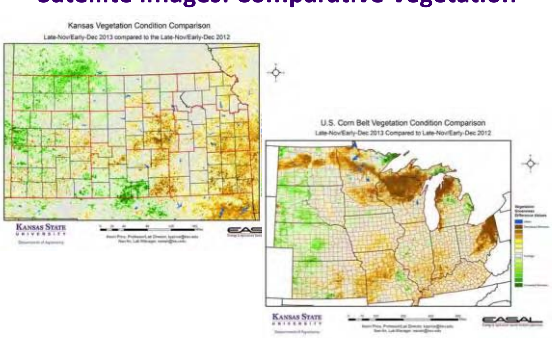
KSU Zephyr sUAS fixed wing aircraft, equipped with a digital CIR camera and a high resolution color video camera.

Common Features

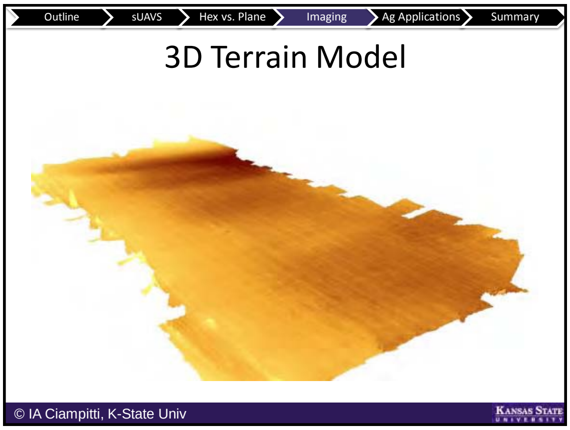
- Color IR digital camera (blue, green, and NIR wavelengths).
- Purpose of Computing the NDVI (Normalized Difference Vegetation Index).

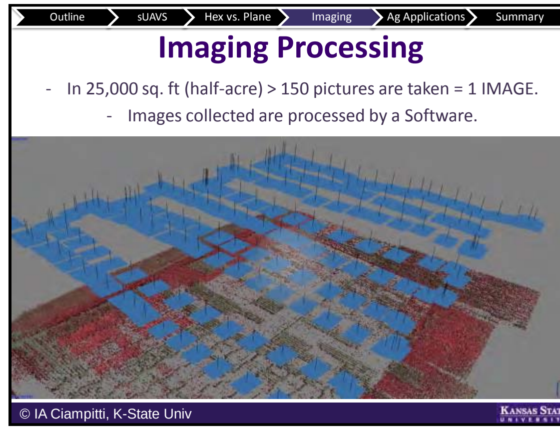
Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Satellite Images: Comparative Vegetation



Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
3D Terrain Model
© IA Ciampitti, K-State Univ


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Imaging Processing
- In 25,000 sq. ft (half-acre) > 150 pictures are taken = 1 IMAGE.
- Images collected are processed by a Software.
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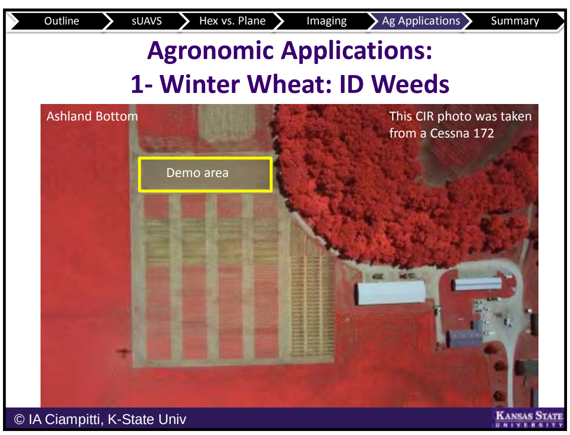
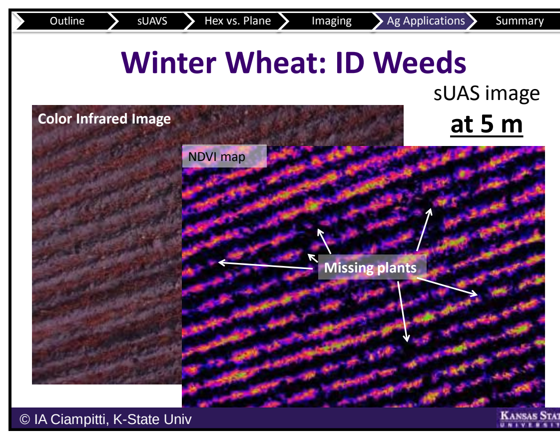

Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Agronomic Applications:
1- Winter Wheat: ID Weeds
Ashland Bottom
This CIR photo was taken from a Cessna 172
Demo area
© IA Ciampitti, K-State Univ


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Winter Wheat: ID Weeds
sUAS image
at 5 m
Color Infrared Image
NDVI map
Missing plants
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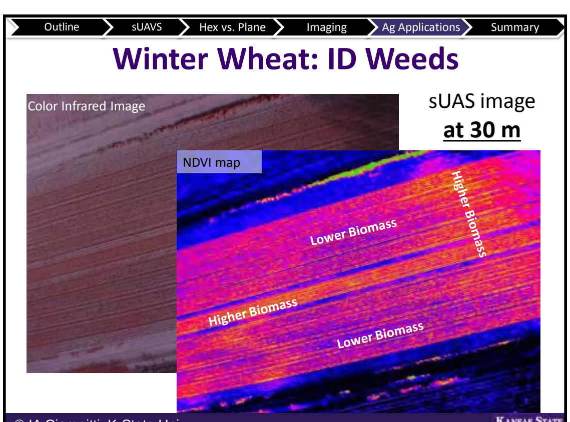
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Winter Wheat: ID Weeds
Color Infrared Image
sUAS image
at 30 m
NDVI map
Higher Biomass
Lower Biomass
Higher Biomass
Lower Biomass
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Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
2- Biomass & Yield: Grain Sorghum
About 50 m
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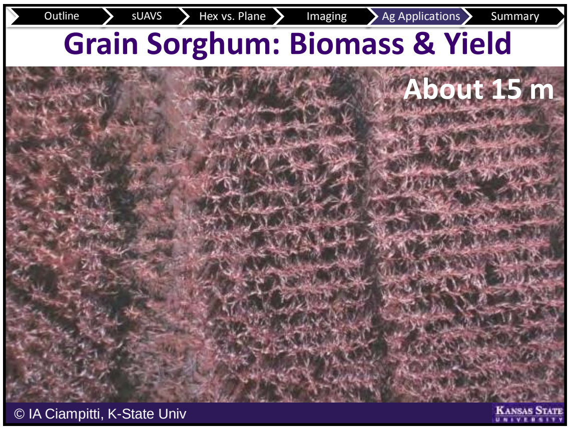
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Grain Sorghum: Biomass & Yield
About 15 m
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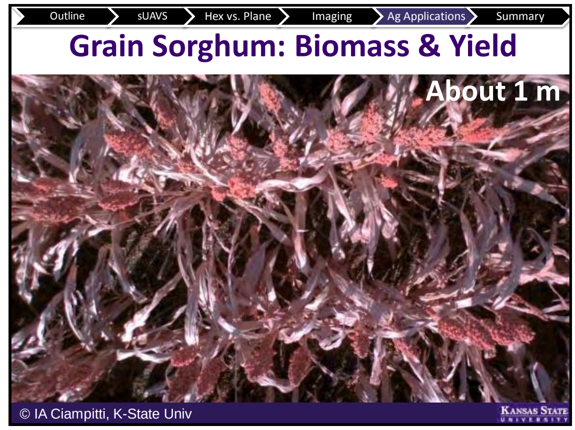
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Grain Sorghum: Biomass & Yield
About 1 m
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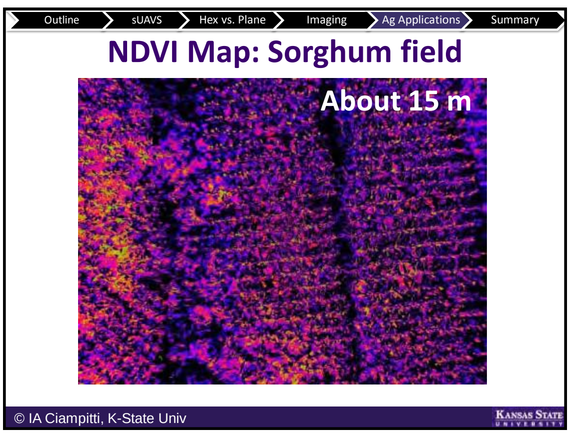
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
NDVI Map: Sorghum field
About 15 m
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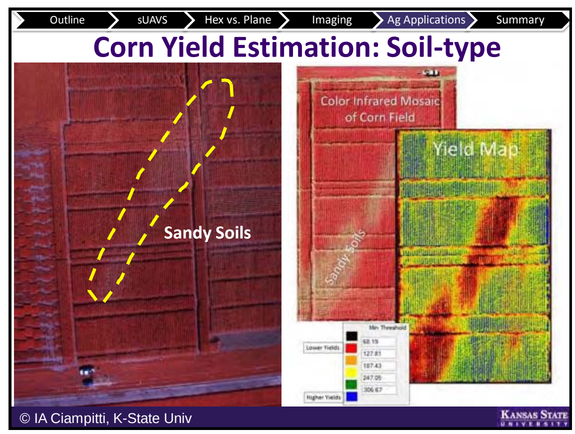
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Corn Yield Estimation: Soil-type
Sandy Soils
Color Infrared Mosaic of Corn Field
Yield Map
Sandy Soils
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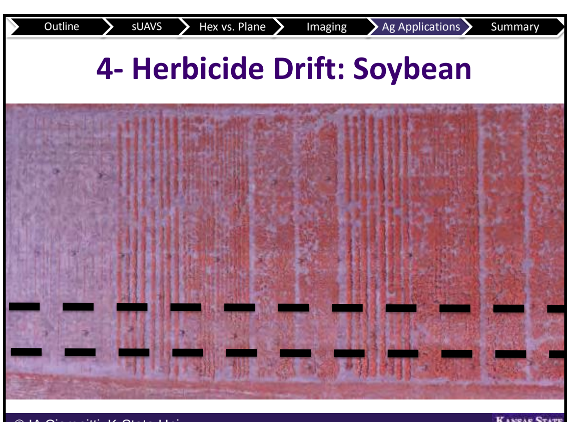
Kansas State University


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
4- Herbicide Drift: Soybean
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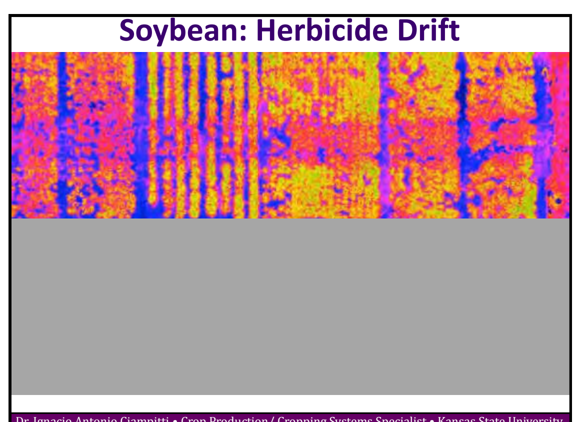
Soybean: Herbicide Drift
Dr. Ignacio Antonio Ciampitti • Crop Production/ Cropping Systems Specialist • Kansas State University


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
5- Crop Re-Planting Tool: Soybean 3-D Imaging
Missing plants
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Kansas State University


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
6- Plant Height Tool: 3-D Imaging (Corn)
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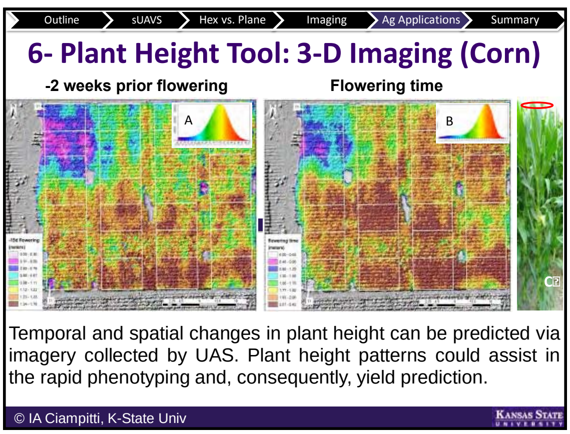
Kansas State University


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
6- Plant Height Tool: 3-D Imaging (Corn)
-2 weeks prior flowering
Flowering time
A
B
Temporal and spatial changes in plant height can be predicted via imagery collected by UAS. Plant height patterns could assist in the rapid phenotyping and, consequently, yield prediction.
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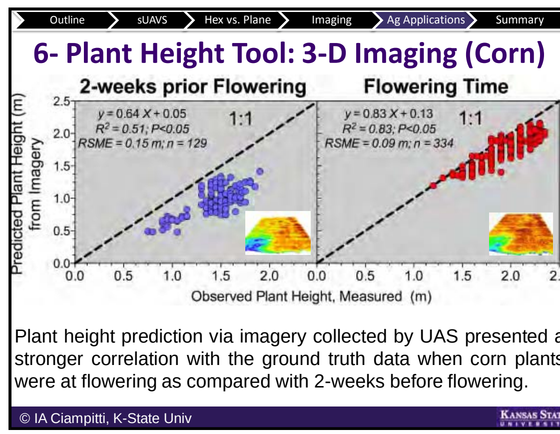
Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
6- Plant Height Tool: 3-D Imaging (Corn)
2-weeks prior Flowering
Flowering Time
y = 0.64 X + 0.05
R² = 0.51; P<0.05
RSME = 0.15 m; n = 129
1:1
y = 0.83 X + 0.13
R² = 0.83; P<0.05
RSME = 0.09 m; n = 334
1:1
Predicted Plant Height (m) from Imagery
Observed Plant Height, Measured (m)
Plant height prediction via imagery collected by UAS presented a stronger correlation with the ground truth data when corn plants were at flowering as compared with 2-weeks before flowering.
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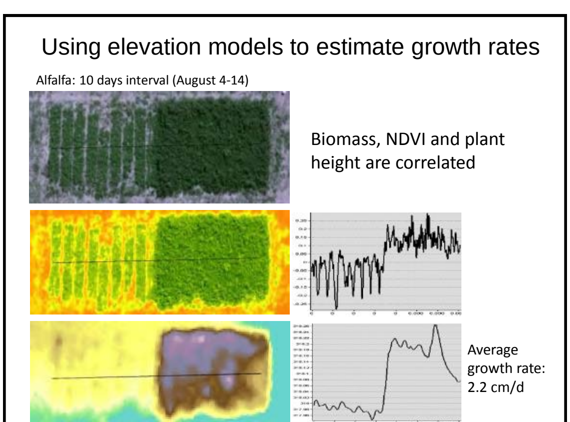
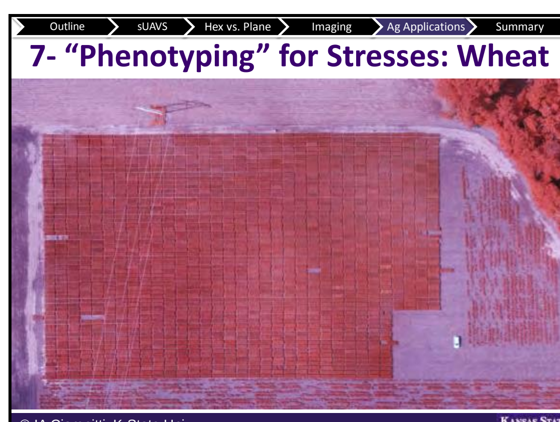
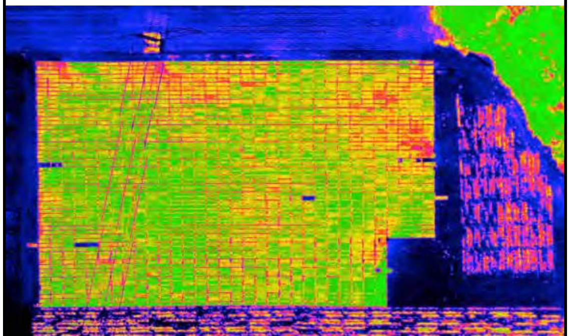
Kansas State University


Using elevation models to estimate growth rates
Alfalfa: 10 days interval (August 4-14)
Biomass, NDVI and plant height are correlated
Average growth rate: 2.2 cm/d


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
7- "Phenotyping" for Stresses: Wheat
© IA Ciampitti, K-State Univ
Kansas State University

Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

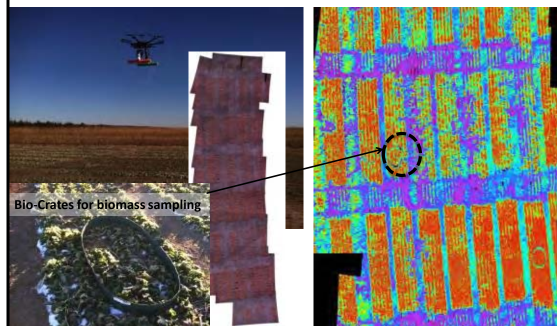
Wheat: Detect Stresses



Kansas State University

Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

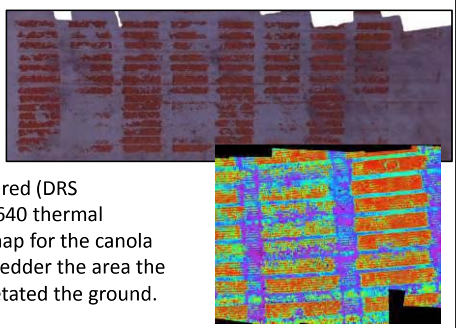
Winter Canola: Re-planting tool



Kansas State University

Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Color Infrared (CIR) — Research



Color infrared (DRS Tamarisk®640 thermal camera) map for the canola field, the redder the area the more vegetated the ground.

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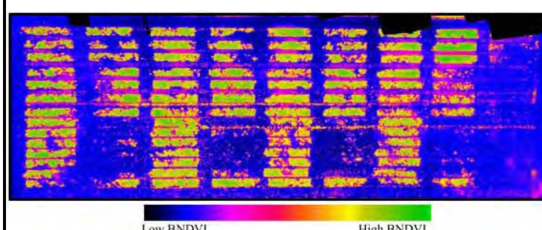
Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Blue NDVI (BNDVI) — Research



Blue NDVI (BNDVI, modified Canon S100 CIR digital camera) map for the canola field, as the color green intensity increases the higher is the canola mass.

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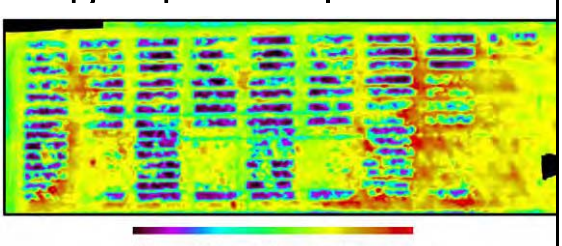
Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Canopy Temperature Map — Research



Colorized temperature map over canola field, depicting differences in canopy temperature among replications measured with the sUAS (04/25).

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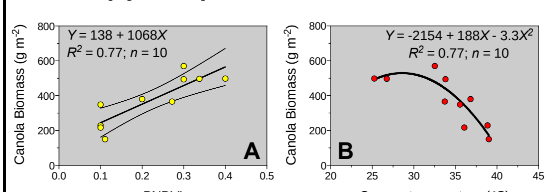
Outline | sUAVS | Hex vs. Plane | Imaging | Ag Applications | Summary

Canola Biomass, BNDVI & Canopy Temperature — Research



- Canola biomass at flowering stage was highly and positively correlated with the BNDVI.
- Canola biomass was negatively associated, but presented a non-lineal relationship with canopy temperature.
- . The model fitted was similar to the one previously documented for the relationship between photosynthesis and temperature at the leaf-scale for corn.

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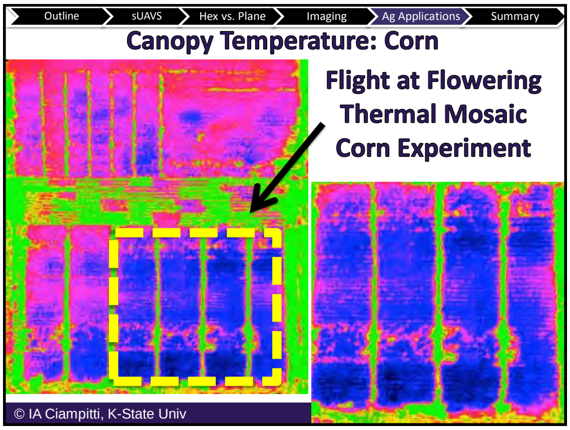
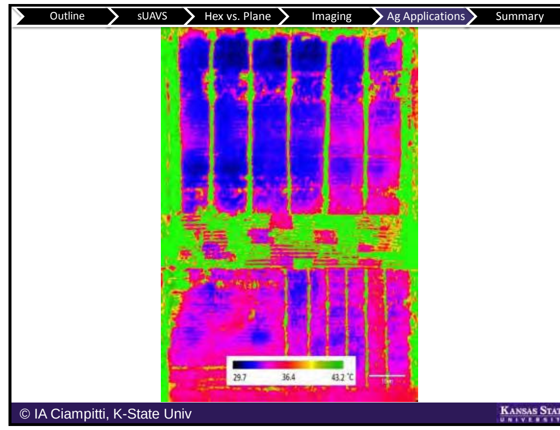
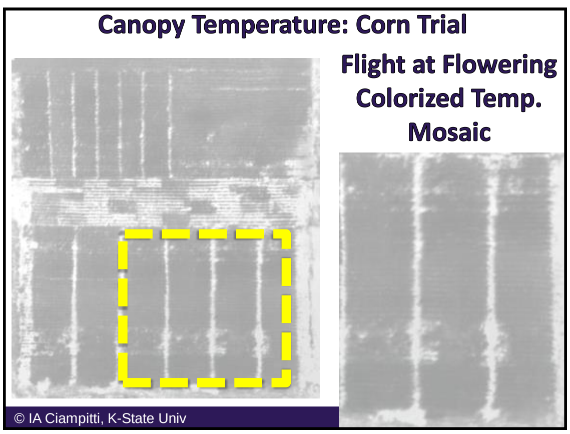
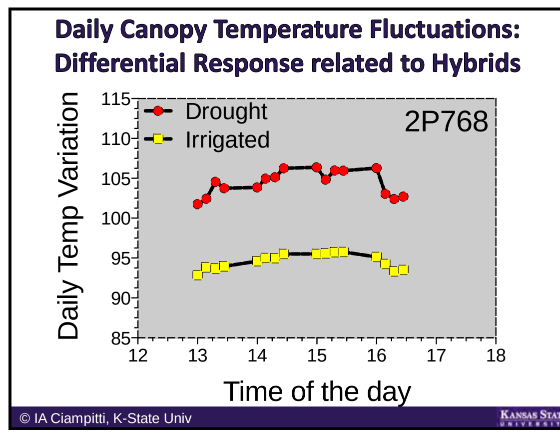

Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
Canopy Temperature: Corn
Flight at Flowering
Thermal Mosaic
Corn Experiment
© IA Ciampitti, K-State Univ


Outline
sUAVS
Hex vs. Plane
Imaging
Ag Applications
Summary
© IA Ciampitti, K-State Univ
Kansas State University


Canopy Temperature: Corn Trial
Flight at Flowering
Colorized Temp.
Mosaic
© IA Ciampitti, K-State Univ


Daily Canopy Temperature Fluctuations:
Differential Response related to Hybrids
Drought
Irrigated
2P768
Daily Temp Variation
115
110
105
100
95
90
85
12
13
14
15
16
17
18
Time of the day
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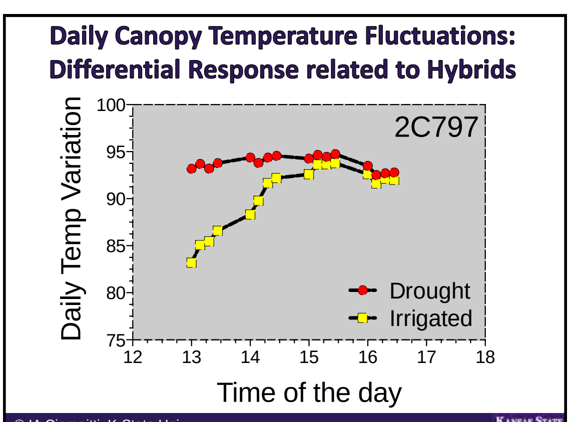
Kansas State University


Daily Canopy Temperature Fluctuations:
Differential Response related to Hybrids
2C797
Daily Temp Variation
100
95
90
85
80
75
Drought
Irrigated
12
13
14
15
16
17
18
Time of the day
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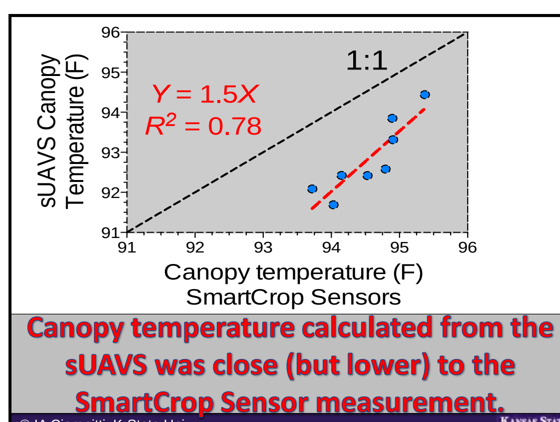
sUAVS Canopy
Temperature (F)
96
95
94
93
92
91
1:1
Y = 1.5X
R2 = 0.78
91
92
93
94
95
96
Canopy temperature (F)
SmartCrop Sensors
Canopy temperature calculated from the
sUAVS was close (but lower) to the
SmartCrop Sensor measurement.
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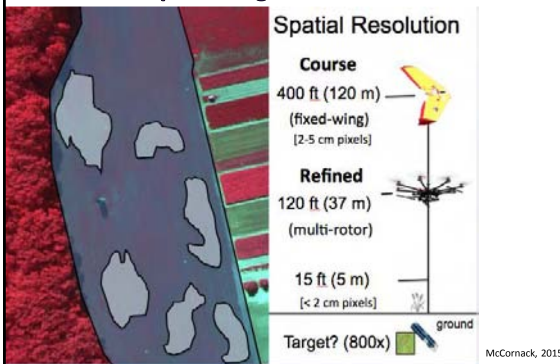
8 – Optimizing Pest Surveillance



McCornack, 2015

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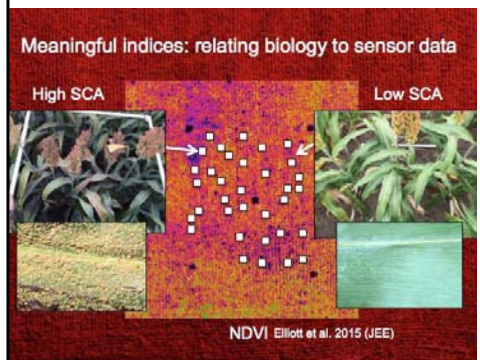
8 – Optimizing Pest Surveillance



McCornack, 2015

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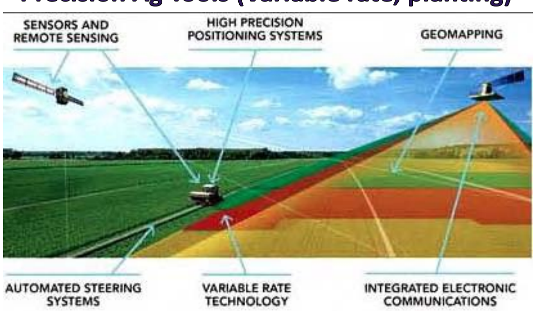
Integration of UAS with Remote Sensing and Precision Ag Tools (Variable rate, planting)



CEMA, http://cema-agri.org

© IA Ciampitti, K-State Univ

Conclusions

- **NEW TECHNOLOGIES**: the use of sUAS will increase the input efficiency and utilization of new precision Ag tools.
- Several Ag applications are possible with the use of this technology.
- New Decision Support Tools are needed in complementary with the use of the technology. Color image = Fertilizer N?
- More applications are currently investigated: yield prediction, canopy temperature in other crops, nutrient status, disease management, etc.
- Service providers are needed and real cost-benefit studies need to be investigated to provide information on this technology.

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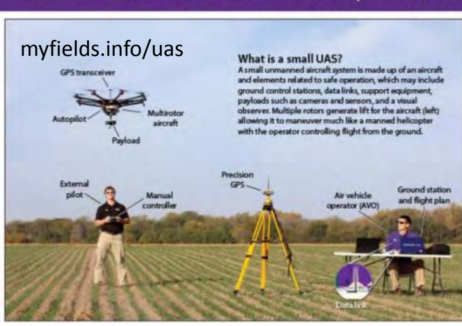
K-STATE Research and Extension

What You Should Know About Small Unmanned Aircraft Systems (UAS)



McCornack, 2015

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THANKS! QUESTIONS?

K-STATE Research and Extension

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Crop Production/ Cropping Systems Specialist

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Ciampitti@ksu.edu

Cover Your Acres – Winter Conference
January 19-20, 2016

National Weather Service
Goodland, KS
Web: weather.gov/gld
Email: nws.goodland@noaa.gov
Phone: 785-899-6412

Find us on Facebook

Topics

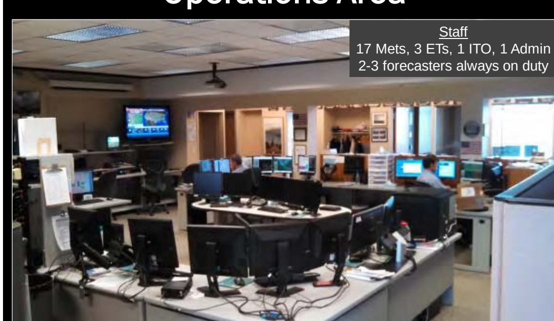
- NWS Goodland Overview
- Navigating NWS web pages
- Measuring precipitation
- CoCoRaHS program
- El Nino: What it is, local impacts

National Weather Service

Executive Branch
⇩
Department of Commerce
⇩
National Oceanic and Atmospheric Administration
⇩
National Weather Service
⇩
WFO Goodland

NWS Field Office Areas of Responsibility

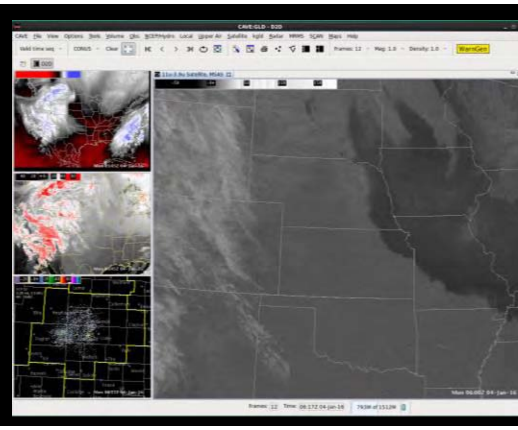
Operations Area

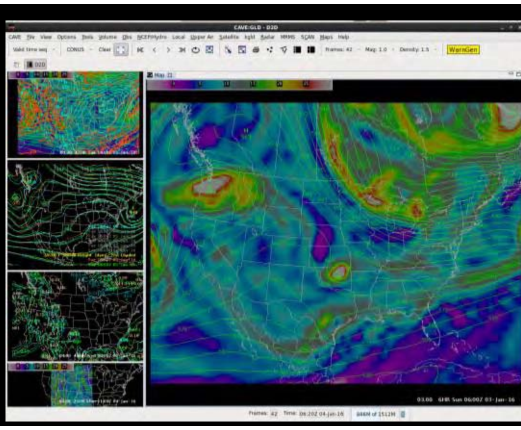


Forecaster Workstation: AWIPS
(Advanced Weather Interactive Processing System)

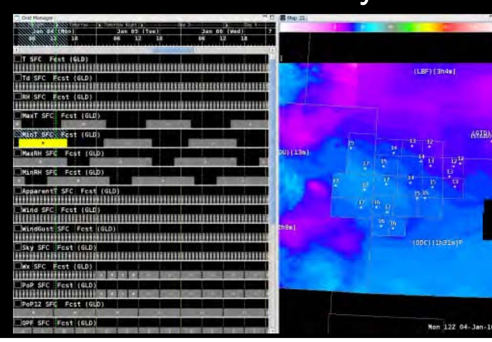
Information Flow

- ASOS & AWOS: Automated Surface Stations
- Automated and manual river gauges
- Doppler Radar
- Cooperative Observers
- Storm Spotters
- NOAA Weather Radio
- AWIPS (surface, upper air, lightning, satellite, radar data, numerical models, WarnGen, Graphical Forecast Editor)
- 800 MHz radio, FEMA NAWAS

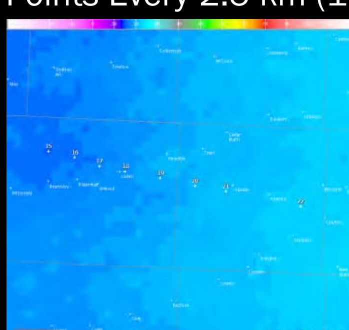




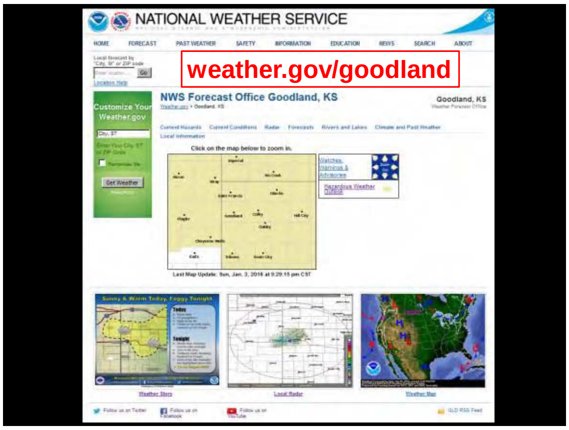
Graphics drawn for 17 weather elements out to 7 days

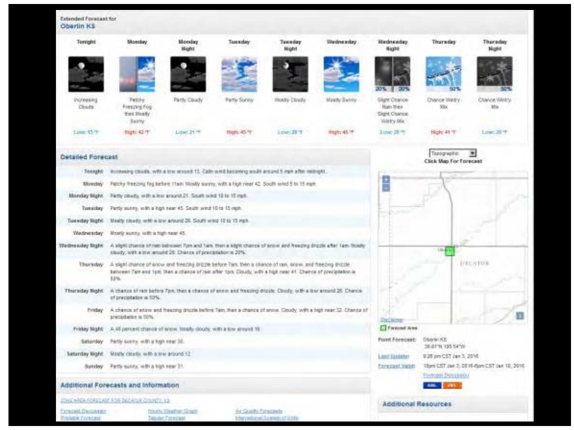


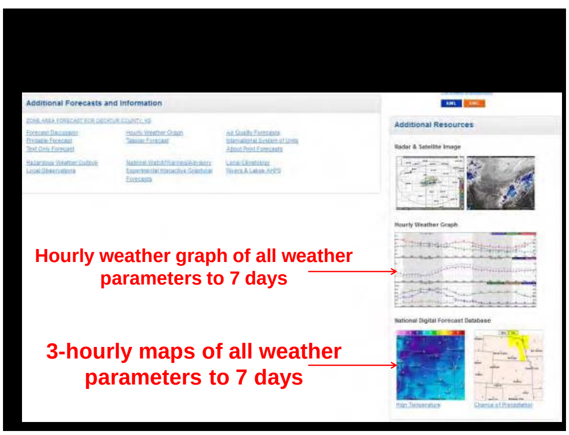
Data Points Every 2.5 km (1.6 mi)

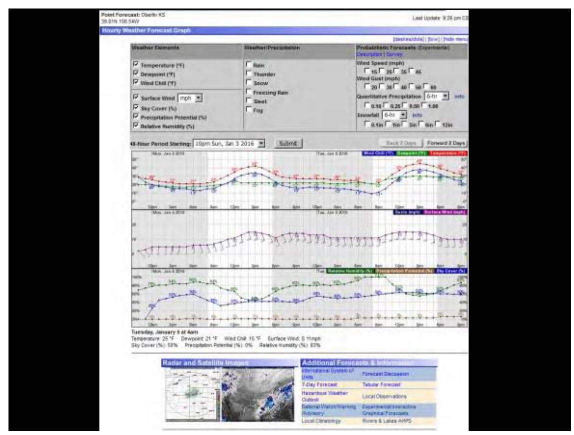


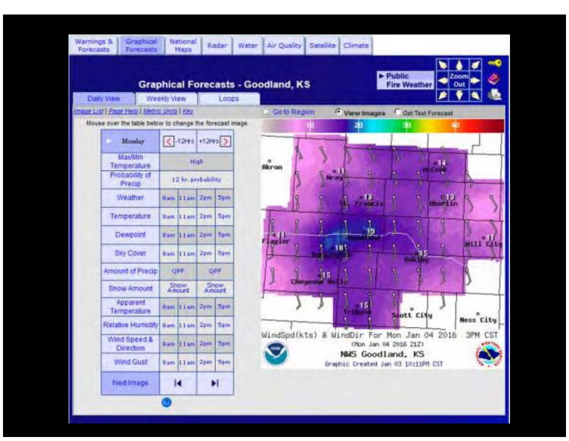
NAVIGATING THE NATIONAL WEATHER SERVICE WEBSITE

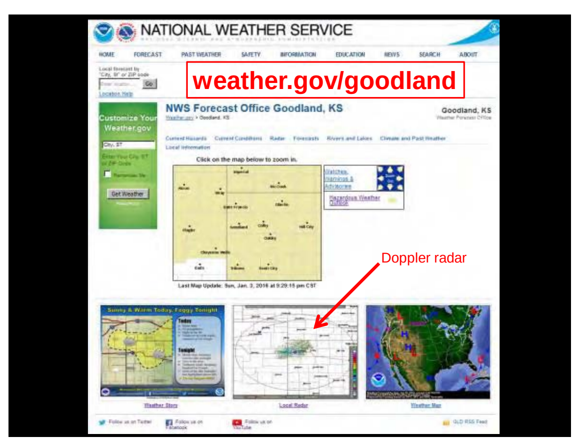

NATIONAL WEATHER SERVICE
weather.gov/goodland
NWS Forecast Office Goodland, KS

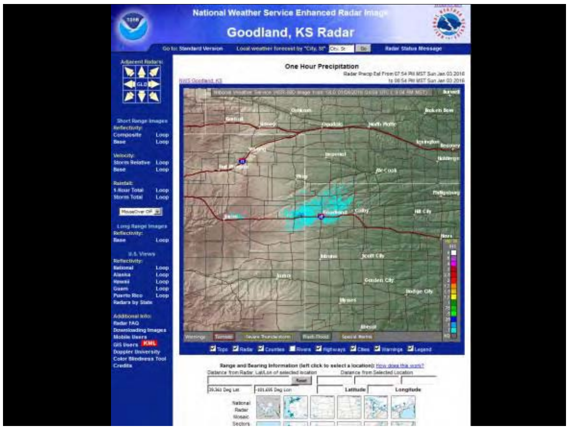

Detailed Forecast
Additional Forecasts and Information
Additional Resources

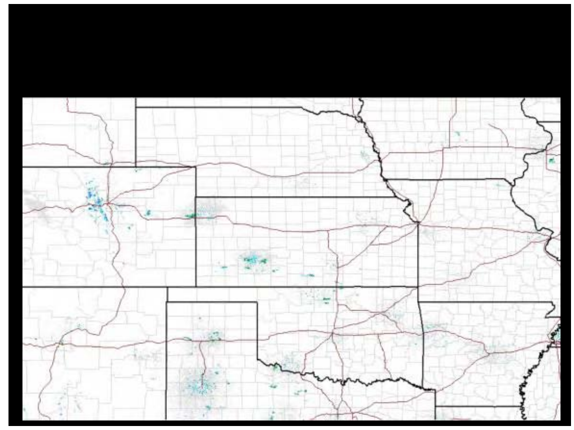

Additional Forecasts and Information
Additional Resources
Hourly weather graph of all weather parameters to 7 days
3-hourly maps of all weather parameters to 7 days

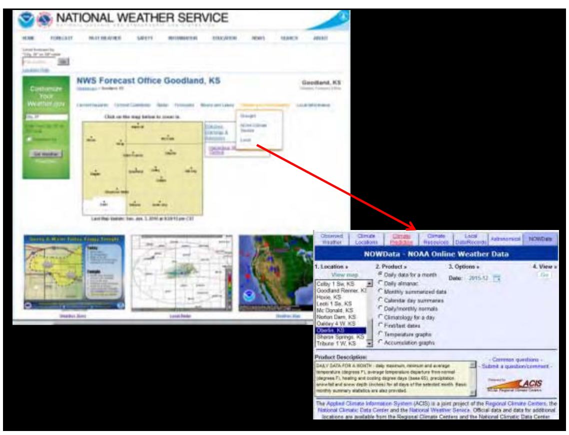

Hourly Weather Forecast Graph

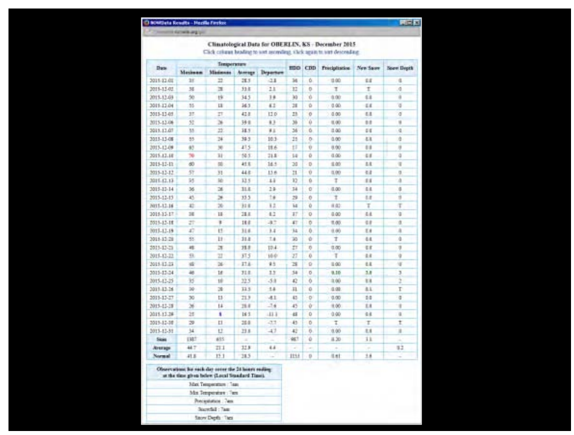

Graphical Forecasts - Goodland, KS

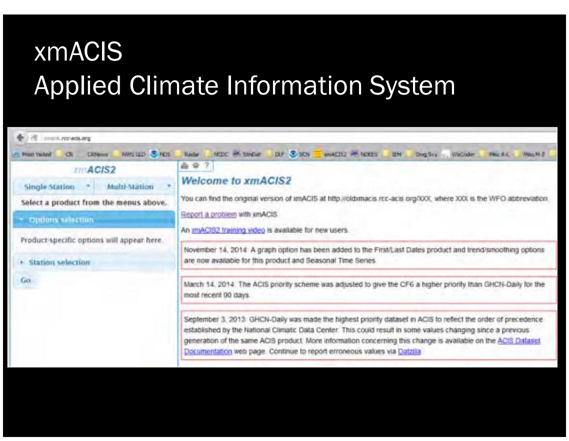

NATIONAL WEATHER SERVICE
weather.gov/goodland
NWS Forecast Office Goodland, KS
Doppler radar

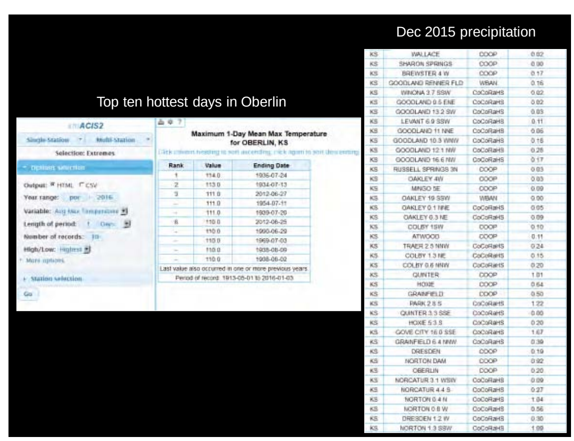

National Weather Service Enhanced Radar Image
Goodland, KS Radar
One Hour Precipitation

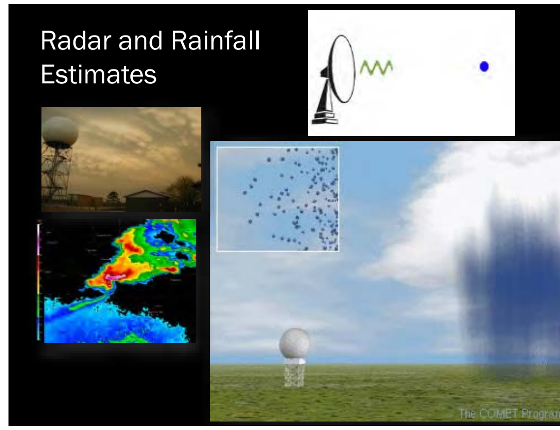


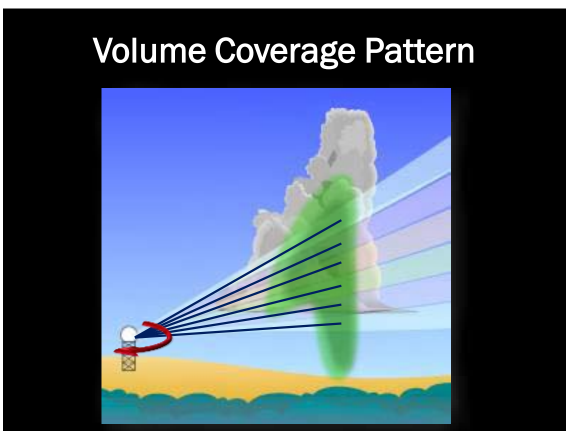

NATIONAL WEATHER SERVICE
NWS Forecast Office Goodland, KS
NOWData - NOAA Online Weather Data

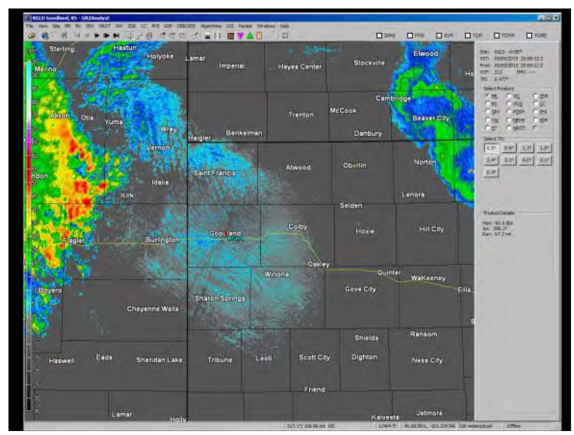

Climatological Data for OBERLIN, KS - December 2015

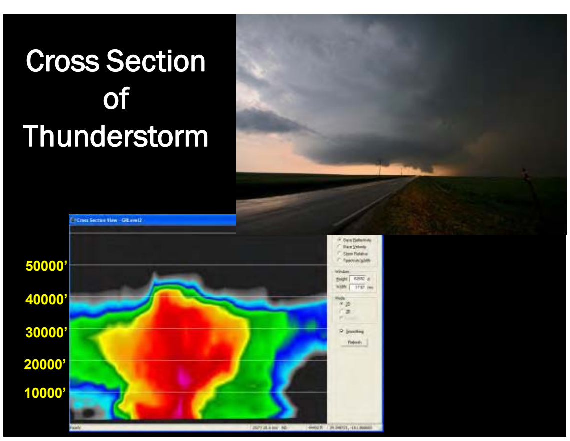

xmACIS
Applied Climate Information System
Welcome to xmACIS2

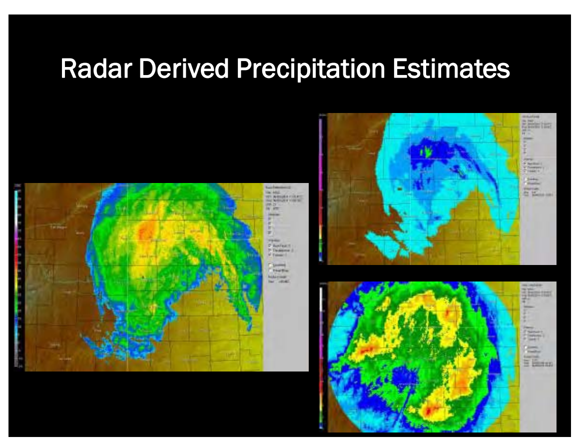

Dec 2015 precipitation
Top ten hottest days in Oberlin
Maximum 1-Day Mean Max Temperature for OBERLIN, KS

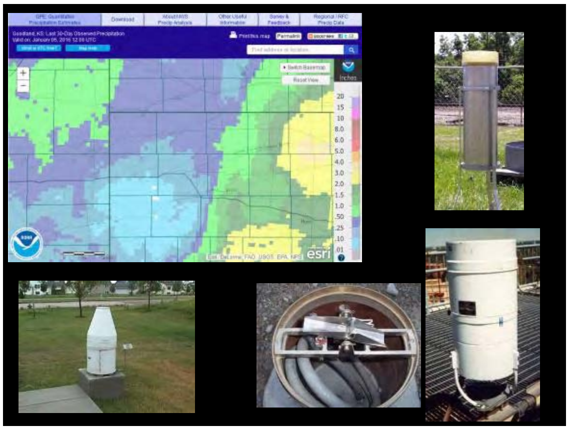

Radar and Rainfall Estimates
The COMET Program

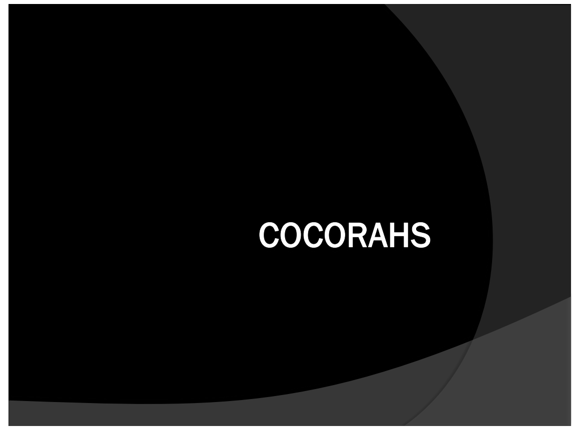

Volume Coverage Pattern


Sterling
Haxtun
Holyoke
Lamar
Imperial
Hayes Center
Stockville
Elwood
Merino
Cambridge
Trenton
McCook
Akron
Otis
Yuma
Wray
Benkelman
Danbury
Beaver City
Haigler
Vernon
Atwood
Oberlin
Norton
Saint Francis
Idalia
Kirk
Lenora
Selden
Colby
Hoxie
Hill City
Goodland
Burlington
Flagler
Oakley
Winona
Quinter
WaKeeney
Gove City
Sharon Springs
Cheyenne Wells
Shields
Ransom
Haswell
Eads
Sheridan Lake
Tribune
Leoti
Scott City
Dighton
Ness City
Friend
Lamar
Jetmore

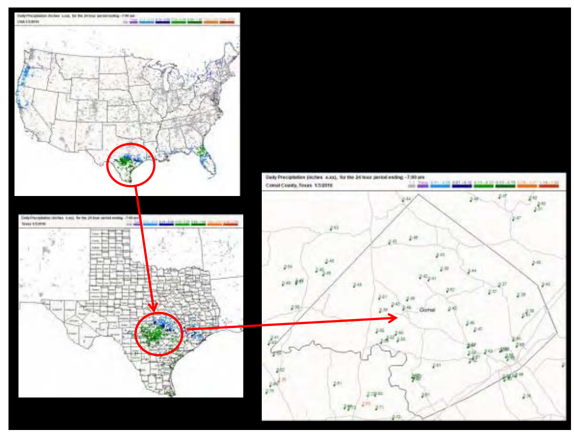

Cross Section of Thunderstorm
50000'
40000'
30000'
20000'
10000'

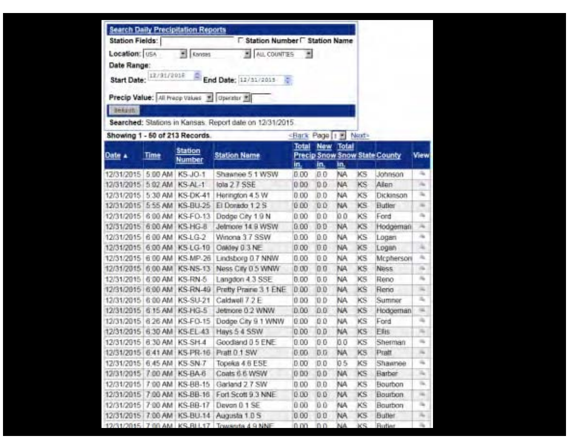

Radar Derived Precipitation Estimates

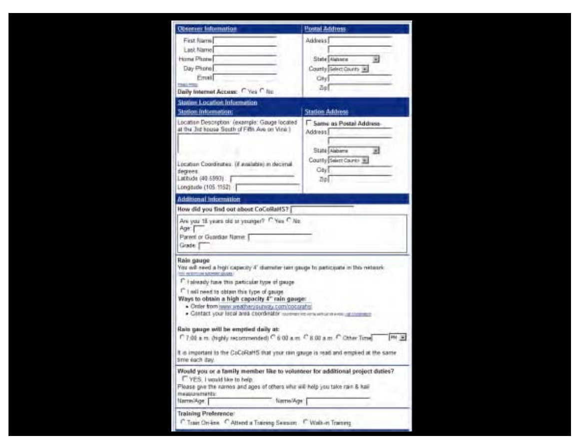



COCORAHS

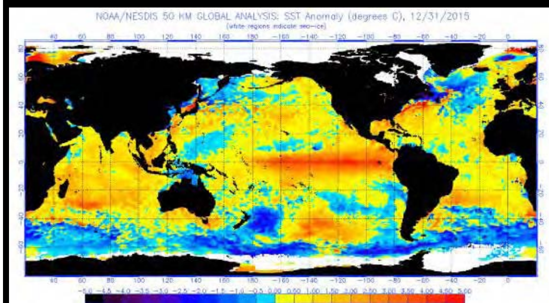

COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK
FIVE FOR COCORAHS
DONATE five dollars
"YEAR END" FUNDRAISER NOW THRU JAN 7, 2016
JOIN COCORAHS
Rain
Hail
Snow
CoCoRaHS Bahamas




Search Daily Precipitation Reports
Showing 1 - 50 of 213 Records.

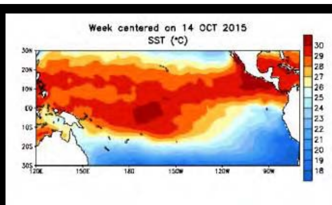

Observer Information
Postal Address
Station Location Information
Additional Information

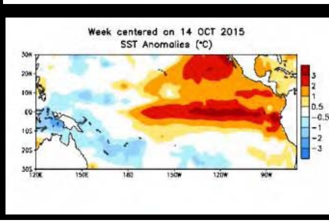
What is El Nino?



Atmosphere responds to warm sea surface by generating persistent episodes of thunderstorms

As a result, jetstream is strengthened over Pacific and southern U.S. This gives more opportunities for unsettled weather from CA to GA.

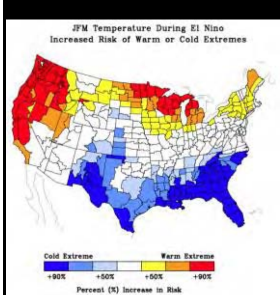


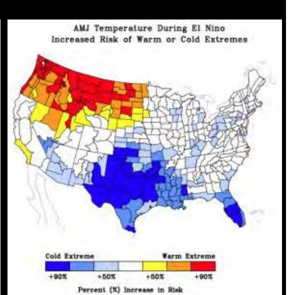


Winter Outlook

- Issued by Climate Prediction Center
- Based upon:
  - Presence of El Nino/La Nina conditions **
  - Recent 10-15 year trends vs normal
  - Persistent wet or dry soil in summer
  - Snow-ice extent
  - Long range forecast models
    - Do not forecast individual storms

Past El Nino's Impact on Temperature

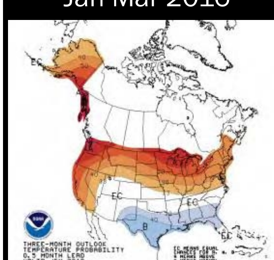




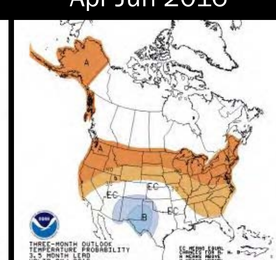
Temperature Outlook

Little signal favoring either warmer or cooler than normal for Colorado and Kansas

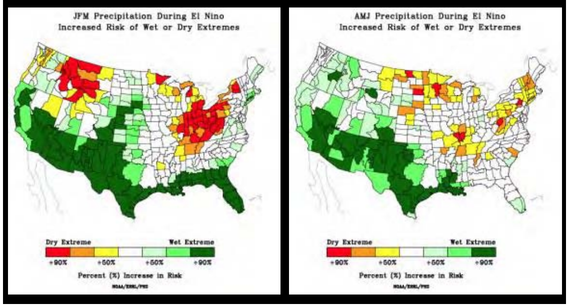
Jan-Mar 2016



Apr-Jun 2016



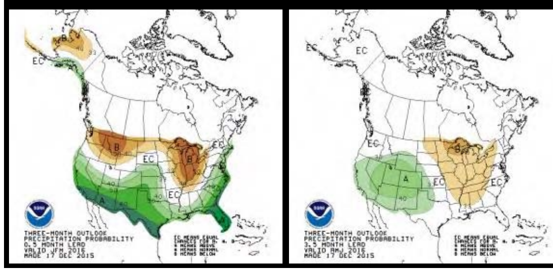
Past El Nino's Impact on Precipitation



Precipitation Outlook

Some signal for above normal winter precipitation (especially later winter) for Colorado - Kansas

Jan-Mar 2016 | Apr-Jun 2016



Okay, so…

- Given the likelihood of a strong El Nino to continue through spring of 2016:
  - Higher confidence of above average Jan-May precipitation…(late winter-early spring)
  - Little confidence in any cold/warm departure.
  - El Nino does not predict individual storms, only background signal

QUESTIONS ?

Considerations When Developing Your 2016 Weed Management Plan

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Managing glyphosate resistant Palmer amaranth and Kochia


ALL ARE TOO BIG!!! Glyphosate Res. Palmer amaranth and Kochia


Plan early! Control a germinating weed!

- Using PREemergence herbicides BEFORE the weed emerges is key to success for management of both kochia and Palmer amaranth!
- My motto for winter meetings!

USE A PRE, or DON'T CALL ME!

Using a PRE allows for a two or more pass system, PRE followed by (*fb*) POST

PRE active ingredients effective on kochia!

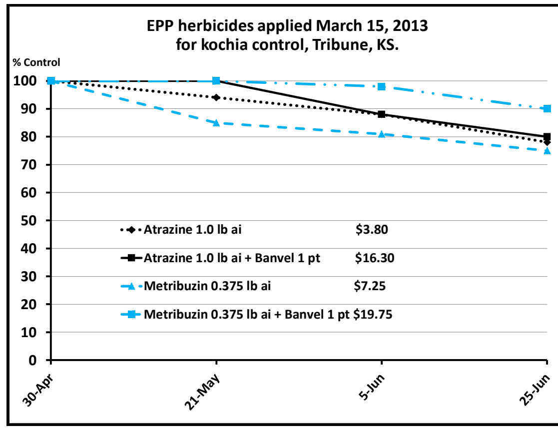
- Triazines (5) $3.80/lb ai, $7.25/0.375 lb ai
  - Atrazine – use when planting corn, sorghum, or millet
  - Metribuzin – use when planting soybean or fallow prior to wheat
- Growth regulators (4) $12.50/pt, $2.43/oz
  - Dicamba –essential needing small amounts of activating rainfall Clarity, Distinct
- HPPD inhibitors (27) $8.72/oz, $5.62/oz, $7.17/oz, $75.65/gal, $63.76/gal
  - Isoxaflutole, Scoparia/Balance Pro, Balance Flexx, or Corvus can be used ahead of fallow to wheat or Flexx & Corvus ahead of corn, Lumax EZ or Lexar EZ ahead of corn or sorghum
- PPO inhibitors (14) $6.46/fl oz, $4.20/fl oz, $26.10/lb
  - Sharpen has excellent activity on kochia – can be used ahead of planting corn, sorghum, soybean, or fallow prior to wheat
  - Sulfentrazone, Spartan or Authority based products. Use ahead of planting soybean, Spartan ahead of sunflower, Authority MTZ ahead of fallow going to wheat.
- Acetamides (15) $9.00/oz, $3.06/fl oz
  - Zidua or Anthem have good activity on kochia. More moisture required for activation. Two 0.75 inch rains are ideal. Essential to mix with dicamba. Can be used ahead of planting corn or soybean or fallow ahead of wheat. Can be mixed with triazine – see above restrictions.

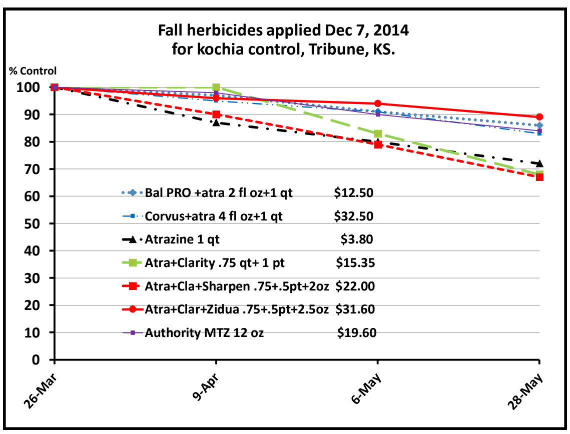
FOR Kochia when do we apply these PRE actives!

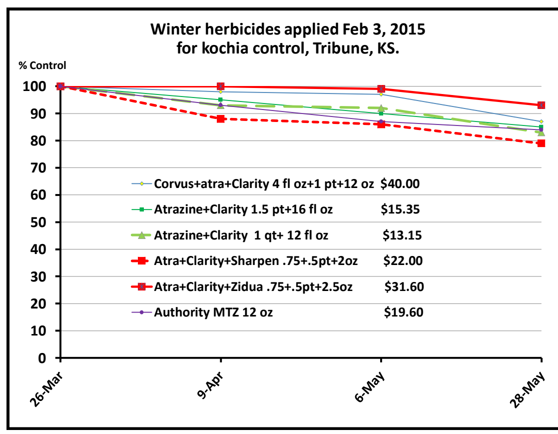
Fall? Winter? Spring?

Cumulative GDD and Date for Start (10%), End (90%), and Duration of Kochia Emergence, Dille etal.

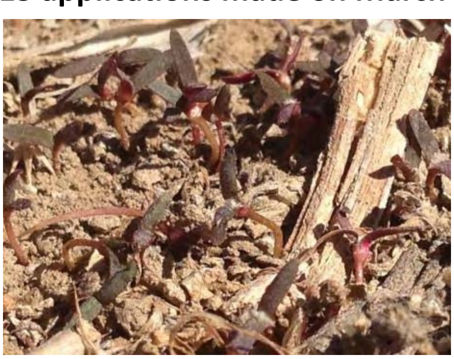
Location & site	Site	GDD to 10% E	Date	GDD to 90% E	Date	GDD Duration 10% to 90% E
Lingle, WY	NC	76	3/21	191	4/10	115
Mitchell, NE	NC	84	3/17	456	5/7	372
Scottsbluff, NE	NC	69	3/15	415	4/29	346
Hays, KS	Crop	238	3/18	365	3/24	127
Hays, KS	NC	137	3/31	173	4/10	36
Ness City, KS	NC	114	3/11	475	4/18	361
Garden City, KS	Crop	283	3/31	1056	5/26	773

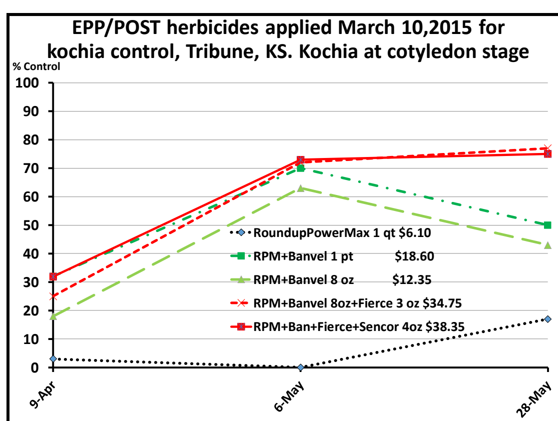




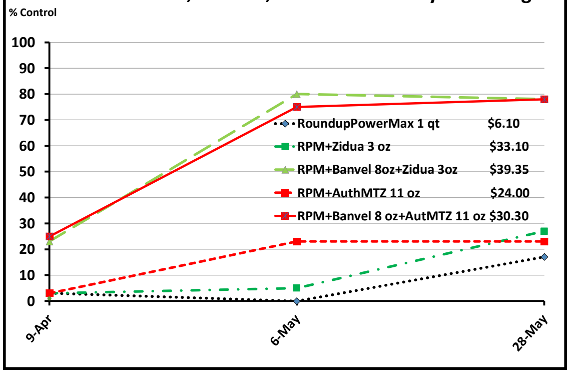


2015 applications made on March 10



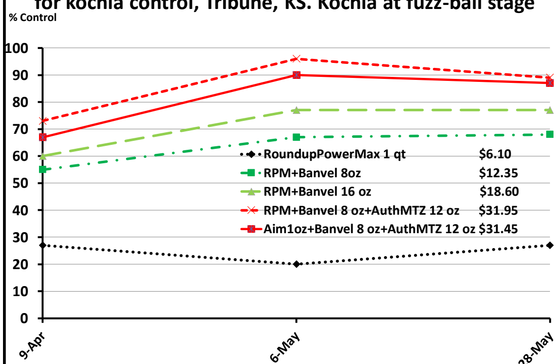


EPP/POST herbicides applied March 10,2015 for kochia control, Tribune, KS. Kochia at cotyledon stage



2015 applications made on March 20

EPP/POST herbicides applied March 20,2015 for kochia control, Tribune, KS. Kochia at fuzz-ball stage

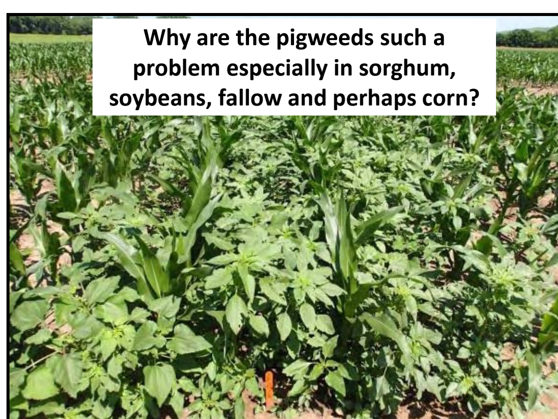


Controlling Glyphosate Resistant Kochia

- Use early preplant before kochia germinate - essential
- Use a PRE herbicide
  - Corn or Sorghum atrazine, dicamba, Sharpen, Verdict, Lexar EZ, Lumax EZ
  - Additional corn, Corvus, Balance Flexx , Zidua, Anthem, Acuron
  - Soybean, Zidua, Anthem, Sharpen, Verdict, Fierce, sulfentrazone (Authority/Spartan), Valor based products are less effective on kochia
- POST herbicide treatments
  - TIMELY, TIMELY, TIMELY
  - Contain dicamba, Clarity, Distinct, Status, DiFlexx, Starane
  - HPPD inhibitors (with atrazine!) ie. Laudis, Callisto, Callisto Xtra, Impact, Halex GT, (Balance Flexx or Corvus – 2 leaf or earlier), Huskie in sorghum

PRE active ingredients effective on Palmer amaranth

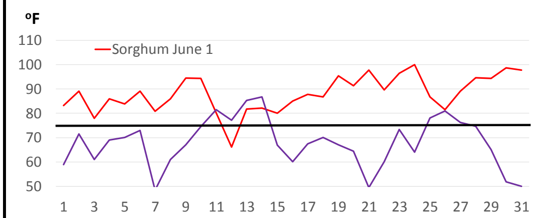
- Triazines (5) $3.80/lb ai, $0.91/dry oz product
  - Atrazine – use in April before planting corn, sorghum, or millet
  - Metribuzin – use ahead of planting soybean
- Chloroacetamides (15) $9/oz, $3.06/fl oz, per gal $118, $137, $118, $33
  - Zidua, Anthem, Dual II Magnum, Outlook, Degree, Harness, Surpass, TopNotch, Breakfree, Warrant ETC.
- HPPD inhibitors (27) $5.62, $7.17, $70/gal, $63.76, $75.65
  - Balance Flexx, Corvus, Acuron before planting corn, Lexar EZ or Lumax EZ ahead of corn or sorghum
- PPO inhibitors (14) $6.46/fl oz,$1.82/fl oz, $4.20/oz, $7.14/oz, $6.47/pt, $12.60/qt
  - Sharpen/Verdict can be used ahead of planting corn, sorghum, soybean see weed guide for rates
  - Sulfentrazone, Spartan or Authority based products ahead of planting soybean, Spartan ahead of sunflower.
  - Valor/Valor based products for beans only, can use Valor at 2 oz rate ahead of corn and sorghum BUT there is a waiting period required!
  - Reflex products, Prefix (Reflex+Dual Magnum) and many others, only use East of Highway 281
- Herbicides with multiple modes of action: $89.36/gal, $108.10/gal, 6.22/oz
  - Corn and sorghum, Lexar, Lumax, Corn only, Acuron, TripleFLEX II, SureStart II, Trisidual, Soybean products with 3 modes of action, Fierce XLT, OpTill Pro

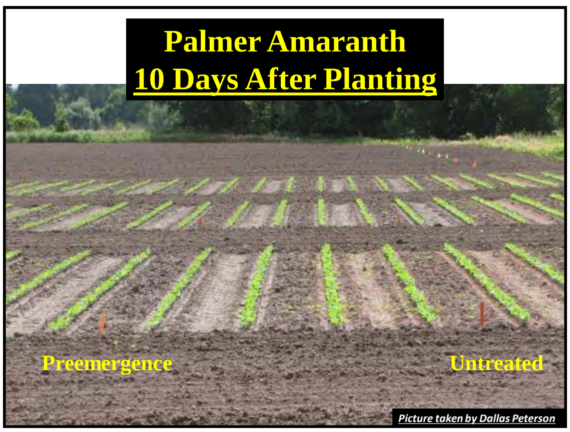


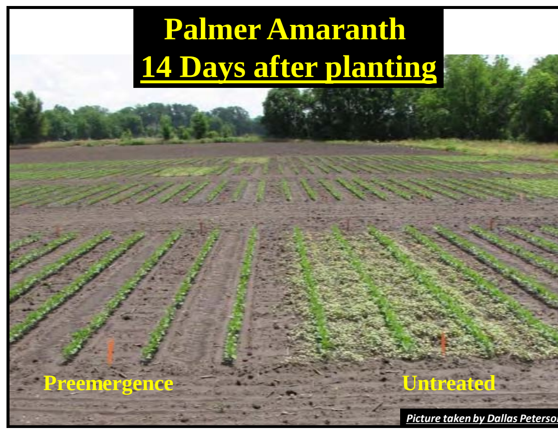
Palmer amaranth and Waterhemp

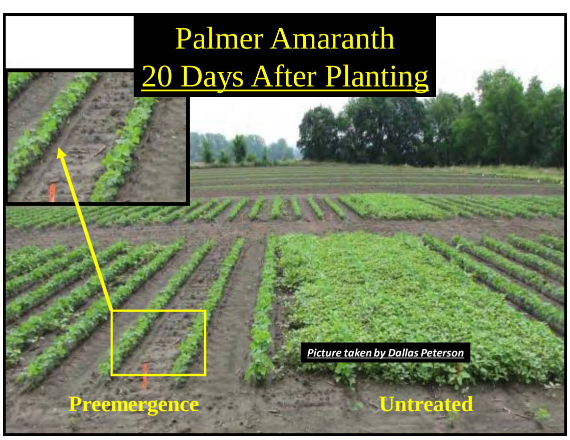
- Rate of Growth function of temperatures. Planting date differences between corn and sorghum are key.
  - In corn, 60's and 70's
  - In sorghum 80's and 90's
    - Less than a week, Palmer can go from 2 inch and controllable to 10 inch and NOT controllable.
  - Sometimes it's difficult to grasp this concept!

Days after planting, 2015 Maximum daily temp Colby









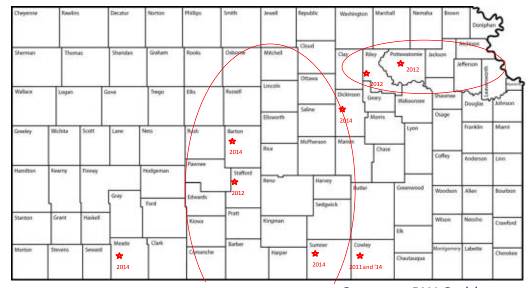
Palmer amaranth and Waterhemp Known resistance somewhere in the USA

- Palmer amaranth
  - ALS
  - Triazine (Both site and metabolism)
  - Glyphosate
  - HPPD
  - PPO (not documented in KS yet)
- Waterhemp
  - All the above!
  - 2,4-D (Nebraska)

How were we handling resistance in corn.

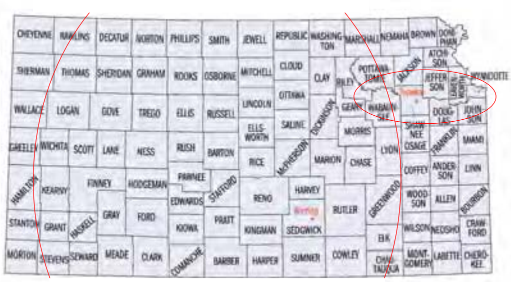
- ALS
  - Basis, Basis Blend, Autumn Super, Python, Accent, Beacon, Spirit, Peak, Permit, Steadfast, Harmony, Resolve, etc.
- Triazine
  - Atrazine, metribuzin
- Glyphosate 2011 in Palmer amaranth

Status of GR Palmer Amaranth in KS, 2014



Courtesy: P.W. Stahlman

Glyphosate Resistant Palmer Amaranth Reports- 2015



R Palmer amaranth

HPPD resistance in Palmer amaranth in Kansas and Nebraska and in Waterhemp in Nebraska, Iowa, and Illinois

- ALS
  - Basis, Basis Blend, Python, Accent, Beacon, Spirit, Peak, Permit, Steadfast etc.
- Triazine, metabolism based (NEW!) Pollen transferred
  - Atrazine, metribuzin
- HPPD, metabolism based (NEW!) Pollen transferred
  - Balance Flexx, Corvus, Impact, Armezon, Callisto, Laudis, Capreno
- What herbicide groups are left to manage this pigweed?
  - Glyphosate, Liberty, PPO's, Growth regulators, and Chloroacetamide's

HPPD resistance in Palmer amaranth in Kansas and Nebraska and in Waterhemp in Nebraska, Iowa, and Illinois

- What herbicide groups are left to manage this pigweed!
  - ~~Glyphosate?, HPPD?, ALS?, Triazines?~~
  - Liberty? Doesn't work out west
  - PPO's,
    - Cadet?, Aim?, Sharpen, Verdict, Valor, Authority/Spartan, Fierce, Prefix, FlexStar, Cobra, Blazer
  - Growth regulators
    - Status, DiFlexx, Clarity, Banvel, generic dicamba, 2,4-D
  - Chloroacetamide's (only effective preemergence)
    - Acetochlor, Dimethenamid-P, Metolachlor, Pyroxasulfone, S-metolachor

Weed management in sorghum, Ashland Bottoms, Manhattan KS, 2015, 1524sorg, Thompson and Peterson

Treatment	Timing	Rate	Cost/a	Yield	Palmer	VELE	MOGY
		Prod. / acre	$	Bu/a	% control 4wk aft POST		
Lumax EZ	Pre	2.7 qt	51.05	100	97	100	100
FulTime NXT	Pre	3 qt	32.30	109	98	55	77
Degree Xtra	Pre	2.9 qt	34.45	115	94	47	70
Bicep II Magnum	Pre	2.1 qt	22.95	86	89	57	87
Verdict+atrazine	Pre	10 oz + 1 qt	18.15+3.80	118	97	100	98
Verd+Outlook+Atra	Pre	10+12.8oz+1qt	18.15+13.70+3.80	127	100	100	100
Lumax EZ Banvel+Atra	Pre *FB* POST	2.7 qt 4 fl oz+1 pt	51.05 3.10+1.90	123	100	100	100
Huskie+Atra+ NIS+AMS	POST	16oz+1pt+ .25%+1lb	14.05+1.90+ 1.05+0.30	103	89	100	97
Hske+Atra+2,4D+ NIS+ AMS	POST	13oz+1 pt+4floz+ .25%+1lb	11.45+1.90+0.65+ 1.05+0.30	92	90	100	100
Untreated				1	--	--	--
		LSD (0.05)		34	11	17	16

June 27, 2015 POST trts applied 6 collar sorghum, 2 to 6" Palmer, 3-6" VELE, 2-4" Mogy

Weed management in conventionally tilled irrigated Corn, Tribune KS, 2014 1410cornTR, Thompson and Schlegel.

Treatment	Time	Rate	Cost/a	Yield	Kochia	Palmer
	App.	Prod. / acre	$	Bu/a	% control	
Corvus+atrazine	PRE	3 oz + 1 qt	21.50+3.90	114	85	81
Anthem ATZ	PRE	2 pt	27.5	106	84	90
Anthem ATZ Solstice+RPM+atra	PRE *fb* POST	2 pt 3.15+32+1 pt	27.50 *fb* 17.15+6.10+1.90	142	90	85
Harness Xtra Roundup Pmax	PRE *fb* POST	3.2 pt 32 oz	20.00 *fb* 6.10	131	91	83
Harness Xtra RPM+Imact+Atra	PRE *fb* POST	3.2 pt/ 32+1.0oz+1pt	20.00 *fb* 6.10+24.35+1.90	158	100	92
Harness Xtra Impact+Atra+Status	PRE *fb* POST	3.2 pt/ 1.0+1pt+3 oz	20.00 *fb* 24.35+1.90+12.05	160	100	90
Solstice+RPM+atra	POST	3.15+32+16 oz	17.15+6.10+1.90	99	78	74
Status+RPM	POST	5 oz + 32 oz	20.10+6.10	84	48	59
Halex GT	POST	3.6 pt	28.20	103	60	91
Untreated/LSD 0.05		LSD 0.05		40/31	9	9

POST trts applied with 1.0% COC-$.55/a with Solstice or 1% MSO-$.80/a with Impact + 17 lb AMS/100 gal -$0.76/a

Weed management in corn, Ashland Bottoms, Manhattan KS, 2015, 1506corn, Thompson and Peterson

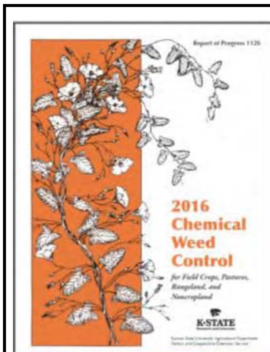
Treatment	Timing	Rate	Cost /a	Yield	Palmer	Vele	Mogy
		Prod. / acre	$	Bu/a	% control, June 22		
Acuron	Pre	2.5 qt	43.75	161	100	97	88
Acuron+atrazine	Pre	2.5 + 1 qt	43.75 + 3.80	164	99	98	84
Acuron HalexGT+NIS+AMS	Pre *fb* Post	1.25 qt *fb* 3.6p+.25+2.5	21.88 28.22+1.05+0.75	173	100	99	97
Acuron Acuron+NIS+AMS	Pre *fb* Post	1.25 qt 1.25+.25+ 8.5	21.88 21.88+1.05+0.38	150	99	100	95
Acuron Callisto GT+AMS	Pre *fb* Post	1.25 qt 2 pt + 8.5 lb	21.88 24.00+0.38	164	100	100	89
Degree Xtra	PRE	3 qts	35.65	155	100	40	85
Harness Xtra 5.6L Impact+Atra+MSO+ AMS	Pre *fb* Post	3.2 pt 0.75oz+.5+.5% +8.5	20.00 18.25+1.90+1.55+ 0.38	151	100	97	92
Untreated				114	-	-	-
		LSD (0.05)		26	3	12	8

Pre's = Apr 22, Epost = May 12 at V2, Post= June 6 at V7

Weed management in corn, Ashland Bottoms, Manhattan KS, 2015, 1506corn, Thompson and Peterson

Treatment	Time	Rate	Cost /a	Yield	Palmer	Vele	Mogy
		Prod. / acre	$	Bu/a	% control, June 22		
SureStart II + atrazine	PRE	2.5 pt + 1 qt	33.80+3.80	151	97	93	83
SureStartII + atrazine Durango + AMS	Pre *fb* Post	2.5 pt+ 1 qt 1 qt+8.5 lbs	33.80+3.80 5.90+0.38	163	100	98	89
SureStart II+atrazine+Durango	EPost	2pt+1+1qt+8.5	27.05+3.80+5.90+. 38	148	98	95	88
Corvus + atrazine	PRE	5.6 oz + 1.5 qt	40.15+5.65	153	95	97	87
Corvus + atrazine RPM+atra+DiFlexx+Adj	PRE *fb* Post	3.3 oz + 1 qt 32oz+1pt+10oz	23.65+3.80 6.10+1.90+19.70+ 2	142	100	97	88
Corvus + atrazine RPM+DiFlexx Duo + Atra + adj	Pre *fb* Post	3.3+1 qt 32oz+32oz+1pt	23.65+3.80 6.10+?.??+1.90+ 2.00	147	100	99	91
Untreated				114	-	-	-
		LSD (0.05)		26	3	12	8

Pre's = Apr 22, Epost = May 12 at V2, Post= June 6 at V7



2016 Chemical Weed Control *for* *Field Crops, Pastures, Rangeland, and Noncropland*

Can be found online! Search for title above, Link http://www.bookstore.ksre.ksu.edu/pubs/CHEMWEEDGUIDE.pdf

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Herbicide Site of Action Resistance in Kochia and Palmer Amaranth

Phil Stahlman, Weed Scientist
KSU Agricultural Research Center-Hays

The vast majority of cropland acres in the United States are treated with chemical herbicides, often more than once a year. Because all natural weed populations may contain very low frequencies of individual plants (biotypes) that are naturally resistant to certain herbicides, an unintended consequence of extensive herbicide use is that frequent repeated use of any herbicide can cause shifts in species composition of weed populations and select for tolerant or resistant biotypes. Numerous studies have found that repeatedly using any single herbicide mechanism of action without alternative management tactics will eventually eliminate susceptible species or biotypes from an existing population and allow naturally tolerant or resistant biotypes to flourish and dominate the population. Herbicide resistance is now widely recognized as the result of adaptive evolution of weed populations to intense selection pressure imposed by herbicides.

Genetic diversity is the heritable genetic variation within and among populations of species. Species with high genetic diversity, especially those that produce large quantities of seed that readily germinate, adapt and evolve faster in response to changing environmental conditions and selection pressures than species with low genetic diversity. Thus, species with high genetic diversity are prone to evolved resistance to herbicides. There is more than one mechanism of resistance for most herbicide modes of action and several known amino acid substitutions within target site proteins that prevent herbicide binding and disruption of critical biochemical pathways. Non-target site resistance mechanisms (e.g. reduced herbicide uptake or translocation, herbicide sequestration, or enhanced metabolism) allow plants to survive by preventing herbicide from reaching the target site or by producing more of the targeted enzyme than the herbicide can inhibit (e.g. over expression or gene amplification).

Currently, herbicide resistance has been confirmed in 247 weed species in 66 countries with evolved resistance to 22 of the 25 known herbicide sites of action (Heap 2016). Developed countries in which in most arable acres are treated with herbicides have the greatest number of weed species resistant to known herbicide sites of action. Most reported cases involve resistance to a single herbicide site of action; however, several major weeds have evolved resistance to two or more sites of action. Examples include kochia and Palmer amaranth, broadleaf weeds of great economic importance throughout Kansas and the Great Plains.

Herbicide-resistant kochia. High genetic diversity in kochia is maintained through substantial gene flow within and between populations by way of protogynous flowering (female stigmas are receptive of pollen from other flowers up to a week before male stamens of that flower shed pollen), facultative open pollination, and tumbleweed mode of seed dispersal over long distances. Kochia has evolved resistance to four herbicide modes of action and in recent years there have been several confirmed cases of multiple site of action resistance.

As early as the mid-1970s, kochia growing along railroad embankments in several states was no longer controlled by triazine herbicides (Photosystem II inhibitors, Groups 5 & 7) after many years of use for complete vegetation control. Triazine-resistant kochia quickly spread into cropland fields throughout the U.S. However, triazine-resistant plants are less fit than triazine-susceptible plants and do not persist in the population in the absence of continued selection. In 1987, selection of kochia and prickly lettuce (*Lactuca serriola* L.) biotypes resistant to sulfonylurea herbicides (ALS inhibitors, Group 2) in Kansas and Idaho was confirmed after as few as five consecutive years of sulfonylurea herbicide use. Evolved resistance to ALS-inhibiting herbicides in multiple species increased at an alarming rate, including ALS-resistant kochia in 13 U.S. states and Canadian provinces within seven years and nearly 150 species worldwide within 25 years after commercialization. As a result of the reduced efficacy of ALS-inhibiting herbicides, growers began using dicamba (Synthetic auxins, Group 4) extensively to control ALS-resistant kochia. It was not surprising then when in 1994 numerous kochia plants were not controlled with field use rates of dicamba in a corn field in Nebraska and in wheat fields in northern Montana following several years of extensive dicamba use in cereal grain crops. More than 15-years later, weed scientists in Nebraska reported an 18-fold difference in dicamba dose required to achieve 90% injury between least and most susceptible kochia plants from four populations. Similarly, K-State weed scientists reported an eight-fold difference between least and most susceptible kochia plants from 11 Kansas populations (Brachtenbach 2015) (Figure 1). Kochia resistance to glyphosate (EPSP synthase inhibitors, Group 9) was first found in four geographically dispersed population in 2007 and by the end of 2012 had spread throughout the central and northern Great Plains and subsequently into the Pacific Northwest (Godar et al. 2015b).

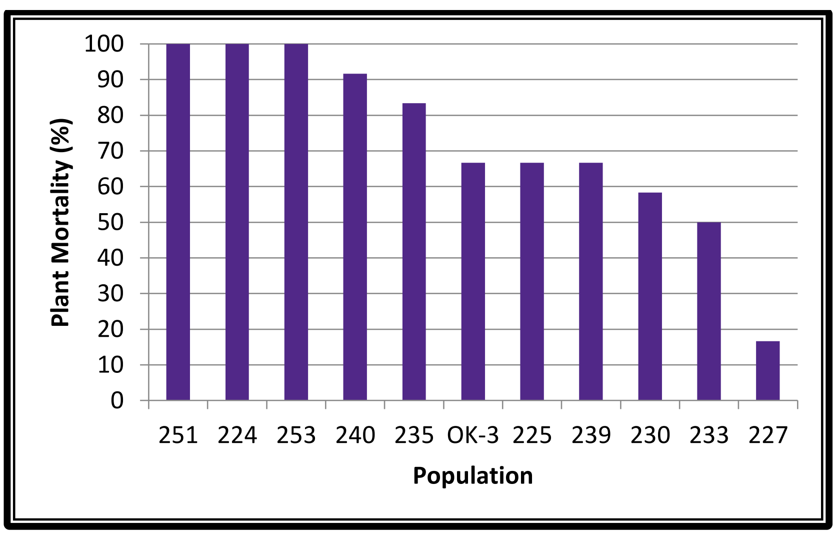

Figure 1. Kochia mortality in response postemergence-applied dicamba at 64 fl oz/A (8x rate).

The first confirmed cases of multiple herbicide resistance was discovery of ALS inhibitor and glyphosate-resistant kochia in western Canada in 2012 (Beckie et al 2013). The following year, K-State weed scientists confirmed the first known case of resistance to four groups of herbicides (atrazine, Group 5; chlorsulfuron, Group 2; glyphosate, Group 9; and dicamba, Group 4) in a single kochia population (Varanasi et al. 2015). The ratio of R:S plants to individual herbicides varied from 25% of plants resistant to atrazine to more than 85% of plants resistant to field use rates of chlorsulfuron, dicamba, and glyphosate. We also have confirmed 3-way resistance in several additional population.

Herbicide-resistant Palmer amaranth. The first case of herbicide resistance in Palmer amaranth was resistance to trifluralin (Microtubule inhibitors, Group 3) in South Carolina in 1989, followed by resistance to atrazine (Group 5) in Texas and Kansas in 1993 and 1995, respectively (Heap 2015). Widespread resistance to ALS inhibitors (Group 2) evolved in several states during the 1990s. But resistance to glyphosate (Group 9), first reported in cotton and soybeans in Georgia in 2005, arguably has had far the greater economic impact than resistance to all other herbicides. Palmer amaranth resistance to glyphosate in Kansas was first confirmed in Cowley Co. in 2011, and in Stafford and Pottawatomie counties in 2012. We collected seed from 157 fields in 24 counties in fall 2014 and screened the populations for resistance to glyphosate in the greenhouse. All plants in 31% of the 157 populations were susceptible (S) to glyphosate; all plants were resistant (R) in 35% of the populations; and 34% of the populations were segregating (contained both R and S plants) (Stahlman, unpublished). In 2015, glyphosate-resistant Palmer amaranth was widespread throughout central and eastern Kansas and was present but less common in western Kansas.

Because of the widespread resistance to both Group 2 and Group 9 herbicides, the occurrence of multiple resistance was inevitable. There have been several confirmed cases of multiple resistance to Group 2 and Group 9 herbicides during the past 3 years (Heap 2016). We are currently testing those same 157 populations for resistance to multiple herbicide sites of action. Though these trials are still ongoing and results are preliminary, it is obvious that many of the populations that are resistant to glyphosate also are resistant to chlorsulfuron and several appear resistant to mesotrione (HPPD inhibitors, Group 27), 2,4-D and dicamba (Group 4).

Implications of Herbicide Resistance. Economic considerations are a major criterion for most growers in making weed management decisions. Thus, it is understandable that most growers are reluctant to proactively change effective weed management practices to more complex and/or expensive practices as long as current practices are still effective. Often the first reactive response to ineffective weed control is to increase herbicide use rate. In response to declining glyphosate effectiveness on kochia, Kansas growers increased glyphosate use rates by 50% and increased application frequencies from 2.0 to 2.9 during the years before discovery of GR-kochia in 2007 to 2012 (Godar et al. 2015a). During that same time period Kansas growers reduced the exclusive use of glyphosate on GR crops from 49 to 15% of fields and began diversifying weed management practices. Clearly, the spread of GR kochia forced changes in practices and increased costs of weed management.

Canadian researchers have concluded the presence of GR weeds will increase environmental impact of weed management by requiring additional herbicides or by growers resorting to tillage to control GR weeds, the latter resulting in reduced soil quality and increased fossil fuel consumption (Beckie et al. 2014). The predicted environmental impact of increased tillage is supported by results of a visual survey of 1500 winter wheat stubble fields in western Kansas in late August 2011 (Stahlman et al. 2013). That survey found 64% of wheat stubble fields had been sprayed with herbicide(s) to control weeds post-harvest and 31% of the fields had been tilled. Some of the tilled fields had been tilled after earlier herbicide treatment failed to control kochia. Poor herbicidal control of kochia in many fields and higher-than-expected percentage of tilled fields indicate a shift to more tillage to control herbicide-resistant kochia following wheat harvest. Evolution of weed resistance to herbicides not only complicates weed management but also threatens sustainable agricultural production and soil and water conservation gains achieved during past decades (CAST 2012).

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K-State Department of Bio and Ag Engineering	www.bae.ksu.edu
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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	Finding Profitability[1] *(M. Wood)*	Weed Resistance: Current and Future[1,2] *(P. Stahlman)*	Managing Soil pH Highs and Lows[1] *(D. Ruiz-Diaz)*	*Sunflower Update (Natl. Sunflower Assoc.) (I)*
9:30	10:20	Soil Biology and Carbon in Dryland Ag[1] *(D. Manter)*	Weather and Ag in the Tri-State Region[1] *(D. Floyd)*	Economics of Soil Fertility Management[1] *(L. Haag)*	*Edible Sunflowers & Farm Planning (Frontier Ag) (I)*
10:20	10:50	*View Exhibits*			
10:50	11:40	Weed Control Strategies[1,2] *(C. Thompson)*	Sorghum and Wheat Insect Issues[1,2] (S. Zukoff)	UAVs in Crop Production[1] *(I. Ciampitti)*	*Chemicals 101 (Sims Fertilizer) (I)*
11:50	12:40	Today's Farm Situation vs. the 1980's[1] *(G. Ibendahl)*	Managing Soil pH Highs and Lows[1] *(D. Ruiz-Diaz)*	*Lunch*	
12:50	1:40	Weed Resistance: Current and Future[1,2] *(P. Stahlman)*	Soil Biology and Carbon in Dryland Ag[1] *(D. Manter)*		
1:50	2:40	Economics of Soil Fertility Management[1] *(L. Haag)*	Weed Control Strategies[1,2] *(C. Thompson)*	Today's Farm Situation vs. the 1980's[1] *(G. Ibendahl)*	*New Innovations from Bayer CropScience (I)*
2:40	3:10	*View Exhibits*			
3:10	4:00	Wheat Seed Industry Discussion Panel	UAVs in Crop Production[1] *(I. Ciampitti)*	Sorghum and Wheat Insect Issues[1,2] (S. Zukoff)	*Importance of Adjuvants (EGE Products) (I)*
4:10	5:00	Weather and Ag in the Tri-State Region[1] *(D. Floyd)*	Finding Profitability[1] *(M. Wood)*	*Encirca Services Decision Tools (Pioneer Hi-Bred) (I)*	*Grazing Cover Crops for Soil Health & Profit (Green Cover Seed) (I)*

(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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