Cover Your Acres Winter Conference

5th Annual

January 22 and 23, 2008

Gateway in Oberlin, KS

Discussing Conservation Crop Production Practices for the High Plains

K-State Research and Extension
& Northwest Kansas Crop Residue Alliance

Schedule for Conference

Time	Room 1	Room 2	Room 3	Room 4	Room 5	Exhibit Hall
7:45 - 8:15 a.m.	Registration					
8:15 - 8:35	Welcome					
	University Sessions			Industry Sessions		
8:45 - 9:33	New Corn Seed Traits for No-till	Improving Your Success in No-till	N Recommendations for Wheat	Outlook for Sorghum, Bioenergy, Food & Export		Sponsor Displays
9:40 - 10:28	Grain Marketing & Revenue Protection	No-till Wheat 101	P Placement and Rate in No-till and Strip-till	Benefits of Chloride on wheat and row crops	What Precision Ag Can Do For You	
10:35 - 11:23	Improving Your Success in No-till	Managing pH in No-till	Comparing Corn and Grain Sorghum Performance	The State of Fertilizer in 2008		
11:30 - 12:30	Farmer Panel: Crop Rotations	Spray Application Technology*		Noon Meal		
12:40 - 1:40	P Placement and Rate in No-till and Strip-till	Soil Quality Change in No-till				
1:50 - 2:38	Ten Crop Sequences Transition to No-till	Effect of Residue on Crop Water Budget	Managing pH in No-till	Plant Stand Management		Sponsor Displays
2:45 - 3:33	N Recommendations for Wheat	New Corn Seed Traits for No-till	Improving Capture and Use of Water	John Deere Technology Improvements and Growth	National Sunflower Association	
3:40 - 4:28	Comparing Corn and Grain Sorghum Performance	Water Rights and Depleting Water	Effect of Residue on Crop Water Budget	Importance of Long Term Care in Estate Planning for Family Farms	Corn Amylase-An output trait that pays a premium.	
4:35 - 5:23	Improving Capture and Use of Water	Spray Application Technology*	Water Rights and Depleting Water	Cellulosic Ethanol	Avoiding Strip-till Mistakes	
5:30 – 7:30	Industry Sponsored Bull Session (refreshments and heavy hors d'oeuvres provided) in the commercial display area **will be held on both nights of the conference.**					

CEU credits for CCAs have been applied for all university sessions except farmer panels. *CEU credits for 1A for Commercial Pesticide Applicators have been approved.

Coordinated by:
Brian Olson, K-State Extension Agronomist – Northwest
Please send comments or suggestions to bolson@oznet.ksu.edu

To become a member of the Northwest Kansas Crop Residue Alliance, please call Brooks Brenn 785-443-1273

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Table of Contents **Page**

GATEWAY Oberlin, Kansas

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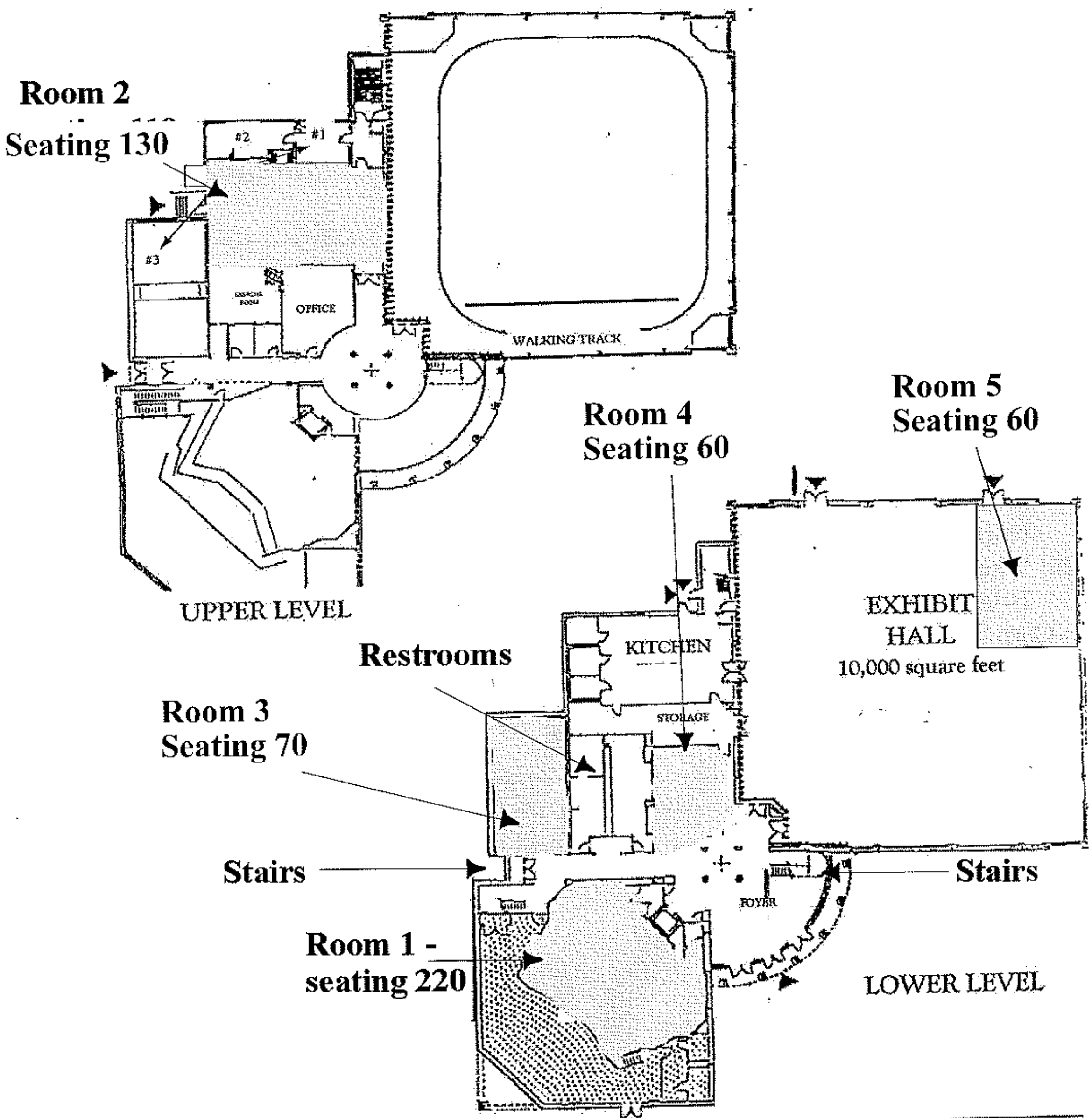


#1 Morgan Drive, Oberlin, Kansas 67749 785.475.2400 Fax 785.475.2925

Industry Sessions	Company Presenter
Outlook for Sorghum, Bioenergy, Food & Export	National Sorghum Producers
Benefits of Chloride on Wheat and Row Crops	Evan's Enterprises
State of Fertilizer in 2008	Cargill AgHorizons
Plant Stand Management	Hoxie Implement
John Deere Technology Improvements and Growth	Southwest Implement
Importance of Long-Term Care in Estate Planning for Family Farms	Waddell and Reed
Cellulosic Ethanol	Kansas Wheat Commission
What Precision Ag Can Do For You	Cargill AgHorizons
Sunflower Production	National Sunflower Assoc.
Corn Amylase – An Output Trait that Pays a Premium	Garst
Avoiding Strip-till Mistakes	Brother's Equipment

Comparing Corn and Grain Sorghum Performance

Kraig Roozeboom[1], Rob Aiken[2], Jane Lingenfelser[1]
[1]K-State Department of Agronomy, [2]Northwest Research-Extension Center

Corn and grain sorghum are important feed and fuel grains in the no-till dryland cropping systems of western Kansas, eastern Colorado, and southwest Nebraska (High Plains). Work by Lloyd Stone and others has shown that sorghum needs less water to produce the first unit of grain, but corn produces more grain per unit of water, once the grain threshold has been met. In high-yielding environments, corn can express this greater water use efficiency (WUE) and generally produces greater yields than sorghum. Sorghum has demonstrated a greater effective WUE in experiments in low-yielding environments because more water is available beyond its lower threshold water requirement for grain production (Table 1). Sorghum may have an advantage over corn in areas where water available for crop growth is less than 20 inches, typical of much of the High Plains region. The average annual precipitation for the three western crop reporting districts in Kansas is 20.72 inches.

Table 1. Water use comparison.

Crop	Threshold Water Use (inches of water for first unit of grain)*	High-Yield, Maximum Water Use (inches)*	High-Yield W.U.E. (lb grain/ in. water)*	Low-Yield, Dryland Water Use (inches)**	Low-Yield W.U.E. (lb grain/ in. water)**
Corn	10.9	25	420	13.9	186
Sorghum	6.9	21	353	14.3	249
Average annual rainfall for western Kansas = 20.72 inches					

*Stone
** Aiken, Lamm, Gordon, Staggenborg

Data from the USDA National Agricultural Statistics Service (NASS) reveal changes in crop acreage allocations and yields in the past 16 years for the High Plains. Dryland corn acreage has increased dramatically from less than 200,000 acres in 1990 to close to one million acres in recent years. Sorghum acreage has fluctuated between 800,000 and 1.8 million acres with little trend up or down over the same time. From 1980 to 2006, average corn yields have been almost 10 bushels/acre greater than average sorghum yields. In recent years (2000 to 2006), that difference has averaged less than a bushel. Although this information is useful and informative at many levels, it does not provide a good comparison of corn and sorghum performance because each crop was likely grown on different fields or in different rotations. For instance, sorghum may have been relegated to less productive sites.

Accurate comparisons between corn and sorghum require that each crop be grown at the same location in close proximity and be managed to optimize production of that crop. Two readily available sources of data provide that type of comparison. Hybrid performance tests have been conducted at several locations for several years, often with corn and sorghum tests in close proximity to each other. In addition, cropping system or rotation studies have been conducted that include both corn and sorghum in similar rotations (most often wheat – corn – fallow).

In recent years, Dr. Barney Gordon and Dr. Kevin Dhuyvetter (K-State Agronomy and K-State Agricultural Economics, respectively) summarized data from studies designed to compare corn and sorghum in the same environment. They combined results from those experiments with hybrid test averages to generate 35 comparisons for south-central and southeast Nebraska and north-central and northeast Kansas. Their analysis concluded that sorghum was economically superior in environments where corn yielded roughly 140 bushels/acre or less, but corn was economically superior in environments were corn yielded more than roughly 140 bushels/acre.

We were able to assemble 75 dryland corn-sorghum comparisons that met the criteria for valid crop comparisons in the High Plains region. Some data was obtained from Nebraska and Colorado, but most comparisons were from Kansas, specifically Thomas and Greeley counties, in northwest and west-central Kansas respectively (Table 2).

Table 2. Locations of corn-sorghum comparisons.

State	County	Comparisons
Colorado	Baca	1
Nebraska	Cheyenne	3
Nebraska	Hayes	3
Nebraska	Perkins	1
Nebraska	Red Willow	4
Kansas	Ellis	10
Kansas	Finney	2
Kansas	Greeley	22
Kansas	Stafford	6
Kansas	Thomas	23
3	10	75

Averaged over all comparisons, sorghum out-yielded corn by 19 bushels/acre (Table 3). The CV was 49% for the sorghum average and 87% for the corn average, indicating much more consistent yields for sorghum. If the comparisons where corn yielded zero were eliminated, the yield advantage for sorghum was only 9 bushels/acre with reductions in the CV for each crop. Corn generally yielded more than sorghum when corn yield was 80 to 90 bushels/acre.

Table 3. Sorghum-Corn comparisons (1992-2007).

	All 75 Comparisons		Non-Zero Corn Trials	
	Average Yield	CV	Average Yield	CV
	bu/a	%	bu/a	%
Sorghum	71	49	75	44
Corn	52	87	66	63

Yield comparisons tell part of the story, but economic comparisons are of greater importance for profitability. Economic comparisons were made using information *from Corn and Grain Sorghum Cost-Return Budgets in Western Kansas* (MF-2150 and MF-904). The greatest cost difference between the crops was for seed, which was roughly $37/acre greater for corn. Returns were calculated using corn and sorghum prices for the three western Kansas crop reporting districts from the January 2, 2008 *Agricultural Prices* report from Kansas Agricultural Statistics.

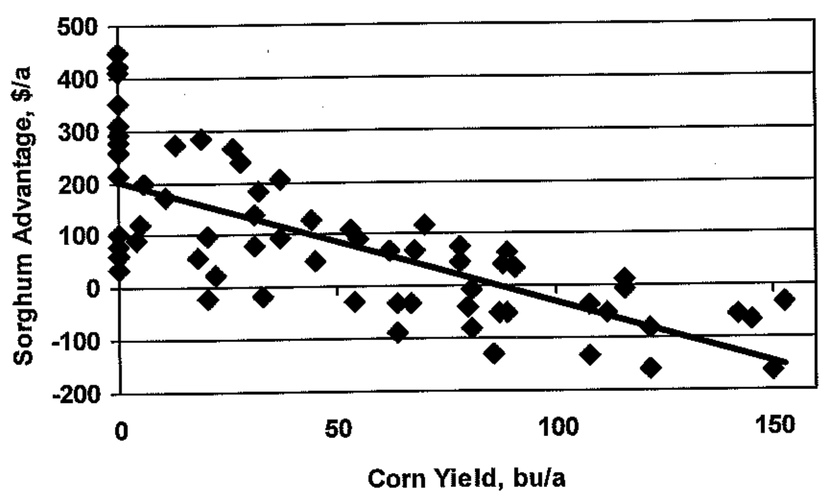
Table 4. Economic assumptions.

	Average Yield for Location		
	60	80	100
Sorghum costs** ($/acre)	$212.01	$247.31	$282.19
Corn costs ($/acre)	$248.21	$284.02	$320.28
Sorghum price ($/bushel)	$3.76	$3.76	$3.76
Corn price ($/bushel)***	$4.01	$4.01	$4.01
Government ($/acre)	$11.22	$12.20	$13.17

*From Corn and Grain Sorghum Cost-Return Budget in Western Kansas MF-2150 and MF-904, Troy J. Dumler et al. Assumes W-C/GS-F rotation.
**Costs include land, labor, machinery, and production costs.
***Prices from January 2, 2008 *Agricultural Prices*, Kansas Ag. Statistics.

An approach similar to that used previously by Gordon and Dhuyvetter was used to summarize the results of the economic analysis. Corn yield was used to characterize the relative productivity of each environment. The economic advantage for sorghum was plotted against corn yield to determine which environments favored corn and which favored sorghum (Figure 1). Given the assumption of a 93.8 sorghum/corn price ratio, the point at which greater profitability switched from sorghum to corn varied with location, but the range was generally between 70 and 95 bushels/acre. In other words, sorghum was more profitable in environments that supported corn yields of 70 to 95 bushels per acre or less. Corn was more profitable in environments that supported corn yields of 70 to 95 bushels/acre or more.

Figure 1. Corn-sorghum economic comparison.



Managing Nitrogen Rates for reduce-till Dryland Wheat

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Introduction: Fertilizer nitrogen (N) costs have increased nearly 70 % in the last 5 years in the Central Great Plains region (CGPR) and increased nearly 35% in the last 10 months. This increase in fertilizer cost, has coincided with a decrease in dryland crop yields due to drought. The question then becomes "should optimal N fertilizer rates be less in dry years with low yields" and if that is the case "how much less"? Another consideration is "how does optimum fertilizer N rate change with wheat price and N cost"? Wheat prices were exceptionally good this past year and the extra value for the commodity also, influences a farmer's choice with respect to optimal N rate. In this manuscript, we evaluate dryland winter wheat yield response to applied N over a four-year period and calculate optimal N rates with changing wheat price and N costs.

Methods: Wheat in a winter wheat-summer fallow, reduce–till system, was fertilized at 0, 30, 60 and 90 lbs of N per acre on a Weld silt loam soil. Fertilizer was applied in a preplant broadcast application as ammonium nitrate. Soil samples (top 2 feet) were collected from each plot at planting time before fertilization and after wheat harvest each year and analyzed for nitrate-N (NO_3-N) and ammonium-N (NH_4-N). Wheat yield was measured (Fig 1a), relative wheat yield was calculated by normalizing each year's wheat yield data on the maximum yield measured in a given year (Fig 1b) and a response function was fitted to that data to determine the economically optimum N rate (Eq [1]). This allowed us to use data that varied from year to year all in one equation (Fig 1b). We then inserted the economics of fertilizer costs at \$0.38-0.64/lb of N and inserted prices of wheat at \$3.72-\$8.72/bushel. A production cost estimate of \$59.7 for winter wheat-millet-fallow was then used as a production cost estimate to develop Eq [2]. Equation 2 was then optimized for different yield scenarios and costs of N to develop table 1, table 2 and table 3.

Eq [1] Relative wheat Yield = 84.67875 +0.46388N -0.00356N^2

Where N is lbs of N per acre and Relative wheat yield is a number between 0 and 100 (R^2=0.78).

Price of N is \$ 0.38, 0.49-0.0.64 per lb actual (UAN at \$240-405/ton and Urea at \$342-576/ton). Wheat price set at \$3.72, \$4.72, \$5.72, \$6.72, \$7.72 and \$8.72 per bushel (10 year ave price for January wheat is ~\$4.00). Assume production costs of \$59.7 for WMF.

Eq [2] Net returns = (a +bN -cN2) * maxyd * Price -0.38N – 59.7

where,

Net returns:	is in \$ per acre
a:	is the y intercept of the N response function (84.67875)
b:	is the linear slope of the response function (0.46388)
c:	is the quadratic slope of the response function (0.00356)
maxyield:	is the wheat grain yield range you are concerned with
Price:	is the grain price in \$ per bushel (\$3.72-8.72).
0.38 :	is the price of fertilizer N in \$ per lb of N (0.38-0.64)
59.7:	is the production costs for wheat in WMF in \$ per acre

The same analysis was generated from a fit of the data where the residual N in the top two feet of the profile was added to the N applied just prior to planting this produced the following equation (Eq [3]).

Eq [3] Relative wheat Yield = 71.79430 +0.55854NapResN -0.00283NapResN^2

Where NapResN is the lbs of N applied per acre, plus the residual N found in the soil (top two feet) at planting and Relative wheat yield is a number between 0 and 100 (R^2=0.73). Residual nitrate-N plus ammonium-N in the top two feet of the soil profile for the N rate experiments presented here were 39, 18, 39 and 24 lbs of N per acre for the years 1995, 1996, 1997 and 1998 respectfully. The average N available for the 4 site-years the experiment was conducted is 30 lbs N in the top two feet of the soil profile prior to planting.

RESULTS: Wheat yield response varied from year to year and was correlated to rainfall and temperature during the growing season (Fig 1a). However, after calculating relative yield the response to N was observed to be similar irrespective of year (Fig 1b). Maximum yield was calculated at 65 lbs of N per acre. However, farmers are more interested in maximizing net returns than in maximizing yield. The data in table 1 provides calculated optimum N rates based on these data (Fig1a) where maximum net returns are expected for various yield ranges and wheat prices.

a b

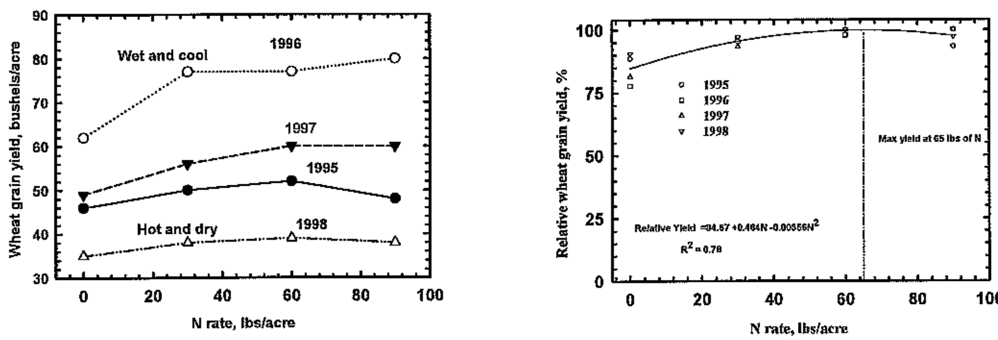

Fig 1. a) Wheat yield as a function of N rate, b) Relative wheat yield as a function of N rate.

For dryland wheat, in dry years the optimum fertilizer N rate is less than 20 lbs with our soils and residual N levels of 18-39 lbs (table 2). For average years, a reasonable N rate is about 20-35 lbs. However, with 45 bushel wheat at $8.72 per bushel, the economically optimum N rate increases to 48 lbs. In high yield years, the economically optimum N rate (the N rate where net returns are maximum) is still in the 40-50 lb range. It never reaches the "maximum relative yield range", which we calculated to be at 65lbs of applied N. Because it is difficult to know if a year is going to be dry/hot or wet/cool it might make sense to fertilize for the average conditions with 30-40 lbs of N most years (table 1). We also generated a table of optimum N rates where we assumed an additional 30% increase in fertilizer prices (table 2). In a Table 2 we see a decline in optimum N rate that is most dramatic in dry years.

We also generated a table using Eq.[3] where the residual N found in the top two feet of the soil profile is included in the regression fit (table 3). The difficulty in generating table 3 was in deciding what $ value to give to the 18-39 lbs of residual N found in these soils. In this analysis we assumed the same $ value of the applied N fertilizer. The N rate plus residual N required to reach maximum yield calculated from Eq.[3] is 99 lbs. Which approximates closely what we expect from adding 30 lbs to the 65 predicted by Eq.[2] (65+30=95). It is not surprising, how the optimum N rate increases if one considers the residual N already in the soil. The trends are similar as in table 1 and 2 in that as yields decline, the optimum N rate declines, and as wheat price increases so does optimum N rate.

Table 1. Economically optimum fertilizer N rate when residual N is 18-39 lbs in the top 2 feet of the soil profile at 6 different wheat prices of $3.72, through $8.72 ($/bushel). Here we assume fertilizer cost $0.49/lb N).

	yield range	$3.72	$4.72	$5.72	$6.72	$7.72	$8.72
Climate	bushels/acre		-------------- optimum N rate, lbs/acre * --------------				
Dry years	15	0	0	0	0	6	13
	20	0	0	5	14	21	26
	25	0	7	17	24	29	34
average years	30	3	17	25	31	35	39
	40	19	29	35	40	43	43
	45	24	33	38	42	45	48
wet years	50	28	36	41	45	47	49
	60	34	41	45	48	50	52
	70	39	44	48	51	52	54

* This table is based on the data analyzed at Akron and is not universal in its application. The array of optimum N rates decreases with a decrease in yield potential and at lower wheat prices. Optimum N rates calculated using Eq.[1].

Table 2. Economically optimum fertilizer N rate when residual N is 18-39 lbs in the top 2 feet of the soil profile at 6 wheat prices of $3.72, through $8.72 ($/bushel). Here we assume a 30% increase in fertilizer cost (N cost =$0.64/lb).

	yield range	$3.72	$4.72	$5.72	$6.72	$7.72	$8.72
Climate	bushels/acre		-------------- optimum N rate, lbs/acre * --------------				
Dry years	15	0	0	0	0	0	0
	20	0	0	0	0	7	14
	25	0	0	2	12	19	24
average years	30	0	2	13	21	26	31
	40	5	18	26	32	36	39
	45	11	23	30	35	39	42
wet years	50	17	27	34	38	42	45
	60	25	33	39	43	46	49
	70	31	38	43	46	49	50

* Optimum N rates calculated using Eq.[1].

Table 3. Economically optimum fertilizer N rate with residual N as part of equation (top 2 feet) at 6 wheat prices of $3.72, through $8.72 ($/bushel). (N cost =$0.49/lb).

	yield range	$3.72	$4.72	$5.72	$6.72	$7.72	$8.72
Climate	bushels/acre		------------- optimum N rate, lbs/acre * -------------				
Dry years	15	0	0	0	13	24	32
	20	0	7	23	34	43	49
	25	6	25	38	47	54	59
average years	30	21	38	48	56	61	66
	40	41	53	61	66	71	74
	45	47	58	65	70	74	77
wet years	50	52	62	68	73	76	79
	60	60	68	73	77	80	82
	70	65	72	77	80	83	84

*. Optimum N rates calculated using Eq.[3]. To use any of these tables a person really should have a good handle on residual N in the top 2 feet of the soil profile. It is interesting that if a person subtracts 30 lbs from the values in this table they will get a good approximation of the data generated in Table 1. The table is based on data analyzed at Akron. It is not universal in its application. The array of optimum N rates decreases with a decrease in yield potential and at lower wheat prices.

Concluding remarks: These optimum N rate tables are helpful in interpreting the general economic relationships with respect to wheat yield and N rate and residual N but are not a substitute for soil testing from a reputable soil test lab. The tables do represent a reasonable guess at N fertility needs for winter wheat planted in dryland-silt loam soils in the CGPR. The analysis indicates that the economically optimum N rate decreases (as might be expected) when yield potential is low, when wheat prices are low, and when N fertilizer costs are high (compare table 1 with table 2 for the same wheat price and yield level). The N rate that is needed to maximize net returns is always less than that needed for maximum yield. Even at the highest yield potential (70 bushel) the calculated optimum N rate in table 2 (which reflects current N prices) is at least 13 lbs less than the N rate required for maximum yield. This analysis is based on data collected from a wheat-fallow reduce-till rotation. We have other N rate response data that we intend to include in the analysis collected from other rotations. We are curious how much the optimal N rate relationships might change with wheat-legume-green fallow, wheat-corn-millet-fallow, and wheat-corn-sunflower-fallow.

This last table (table 4) is how it use to be, 2 years ago, when N prices were 30% lower than today. In those days we could add a little more N at the same yield potential and make it work. However even at that time the maximum N recommended did not exceed 55 lbs at a yield potential of 70 bushel and at a $7.72 wheat price.

Table 4. Economically optimum fertilizer N rate (the fertilizer rate at which maximum net returns are expected) for various yield ranges and wheat prices. Residual N is 20-40 lbs in the top 2 feet of the soil profile. Wheat prices used are $3.72, $4.72, $5.72, 6.72 and $7.72 per bushel. N cost at $ 0.38/lb actual.

	yield range		$3.72	$4.72	$5.72	$6.72	$7.72
Climate	bushels/acre		---------------- optimum N rate, lbs/acre ----------------				
dry years	15		0	0	3	12	19
	20		0	9	18	25	31
	25		8	20	28	33	37
average years	30		17	27	34	39	42
	40		29	37	42	45	48
	45		33	40	44	48	50
wet years	50		36	43	46	49	51
	60		41	46	50	52	54
	70		45	49	52	54	55

* This table is based on the data analyzed at Akron and is not universal in its application. The array of optimum N rates decreases with a decrease in yield potential and at lower wheat prices.

PHOSPHORUS AND POTASSIUM PLACEMENT IN WESTERN KANSAS

David B. Mengel and Kent L. Martin
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No-till and reduced till cropping systems have several advantages over conventional till cropping systems, such as conservation of soil moisture, enhanced rainfall and irrigation infiltration, increased soil organic matter concentration near the soil surface, increased microbial activity, and decreased soil erosion. From 1990 to 2004, the United States conservation tillage acres (including NT) increased from 26.1 to 40.7% of cropland. Of these acres, 6.0% was NT in 1990 and 22.6% was NT in 2004. It is also well documented that the increase in NT and reduced till practices has lead to nutrient stratification, similar to what is found in natural grassland systems, with high concentrations of nutrients in the surface 2-3 inches of soil, and reduced nutrient levels below.

Western Kansas farmers have moved quickly to adapt NT and reduced till systems, primarily as a means of conserving water. Work at Tribune and other locations has shown that no-till production generally provides about two inches of additional water to a summer crop. While these tillage systems conserve moisture below the surface residue they also create cooler, and potentially wetter soil conditions at planting. The cooler temperatures can result in slower earlier season growth on crops such as corn and wheat, though the higher P soil tests due to stratification help off-set this through increased nutrient availability near seedlings. But, will starter fertilizer enhance early growth and result in higher yield, or stimulate excess vegetative growth? Phosphorus and K stratification can potentially reduce P and/or K uptake under dry conditions when the surface soil dries, limiting root activity (though if water is severely limiting, it doesn't really make much difference). Would placing these nutrients deeper in the soil through strip tillage enhance availability? This paper will focus on an on-going P placement study that was initiated in 2005 to obtain answers to some of those questions.

The specific objectives of this study are to: 1.) Determine if P availability is reduced due to stratification, 2.) Determine if deep banding of P enhances availability as compared to surface broadcasting , 3.) Evaluate the impact of starter P fertilizer vs. no starter fertilizer on early season growth and final yield.

The objectives of this study are: 1. To determine if P availability is reduced due to nutrient stratification, 2). To Evaluate how P placement could impact P availability in P stratified soils, and 3). determine if starter fertilizer could enhance early season growth and P uptake, and see if that had any impact on final yield of the crop.

Materials and Methods

This study was established in the fall of 2005 at four locations: Manhattan, Tribune, Ottawa, and Scandia, KS. All sites selected had a history of reduced tillage. The design for this experiment was a randomized complete block with three replications at Manhattan and four replications at all other locations. Each site had appropriate rotations and production practices for the respective area (Table 1). All crops were present at each location each year.

Table 1. Experimental locations and crop rotations.

Location	Rotation
Manhattan	Wheat/Sorghum/Soybeans
Tribune	Wheat/Sorghum/Fallow
Ottawa	Corn/Soybeans
Scandia	Corn/Soybeans

All sites were rainfed, with the exception of Scandia, which received supplemental irrigation using a lateral move sprinkler system. Mean annual Rainfall (1971-2001) at each location was: Manhattan, 34.8 in; Tribune, 17.4 in; Ottawa, 39.2 in; Scandia, 28.0 in.

Initial soil samples were taken at each location prior to making the first fertilizer applications or planting the first crop. One 1.25 in diameter core was taken from each plot to a depth of 24 in. Each core was divided into 0-3 in, 3-6 in, 6-9 in, 9-12 in, and 12-24 in segments to estimate initial stratification at the site, with the individual segments combined for each replication and analyzed for Mehlich 3 extractable P content (Mehlich, 1984). Results from each replication were averaged for each depth at each location (Table 2).

Each site had a true check (0 P applied) and treatments involving three rate/placement factors: starter (20 lb $P_2O_5ac^{-1}$) and no starter; surface broadcast P (low rate 40 lb P_2O_5 ac^{-1}, high rate 80 lb P_2O_5 ac^{-1}; deep banded P (low rate 40 lb P_2O_5 ac^{-1} high rate 80 lb P_2O_5 ac^{-1}, and combinations of broadcast and deep band with starter to reach a total application rate of 40 lb P_2O_5 ac^{-1} and 80 lb P_2O_5 ac^{-1} (e.g. 20 lb P_2O_5 ac^{-1} starter and 20 lb P_2O_5 ac^{-1} broadcast to total 40 lb P_2O_5 ac^{-1} application).

Starter treatments were applied as a 2 by 2 band (2 inches below and 2 inches to the side of the seed) in row crops and with the seed in wheat. Broadcast treatments were applied on the soil surface immediately before planting. Deep band treatments were applied with a strip till unit in row crops. For strip tilling in row crops, conventional strip till units were used that tilled a 7 to 9 inch zone directly over the previous crop row and applied liquid ammonium polyphosphate (APP) at a depth of 6 to 7 inches. In wheat, deep placement was accomplished by using a coulter applicator on 15 in centers and injecting APP 4 to 5 inches deep. In all application methods, nitrogen (N) rate was held constant at an appropriate rate for each crop and location.

Results and Discussion

The locations in this study can be divided into two groups based on soil test levels and crop rotation. The Manhattan and Tribune locations both have P levels greater than the accepted sufficiency level of 20 ppm P (Leikam et al., 2003) with previously established vertical P stratification (Table 2). Due to the high P levels at both locations, P response would not be expected unless stratification of the P would somehow limit P availability. These locations are also rainfed and are well suited for wheat and sorghum (and soybean at Manhattan) production.

The Ottawa and Scandia locations both have soil test levels well below the 20 ppm sufficiency level and have established vertical P stratification (Table 2). The Ottawa location typically receives more timely rainfall and is located in an area where rainfed corn production is commonplace. The Scandia location naturally receives less rainfall, but has supplemental irrigation capabilities. The Ottawa and Scandia locations are in regions where corn/soybean rotations are the norm.

Table 2. Soil test P (ppm) of each site with increasing depth.

Sample Depth (in)	Manhattan	Scandia	Ottawa	Tribune
	--------------------------	---P (ppm)---	--------------------------	
0-3 in	55.4	9.5	9.4	74.1
3-6 in	19.9	5.7	5.8	31.3
6-9 in	7.0	5.1	4.8	10.3
9-12 in	4.2	5.4	4.7	13.4
12-24 in	3.4	4.6	4.6	23.5

The wheat at Manhattan and Tribune did not respond to P in three of the four trials (wheat data not shown). At Manhattan in 2007, there was a yield response to P application, probably due to a severe April freeze; however, there was not an affect due to rate or placement on yield. This result is to be expected with the high available P at both sites as indicated by soil tests.

At Manhattan, a significant response to P was seen with sorghum in both 2006 and 2007. In 2006, the 40 lb ac^{-1} broadcast and deep band treatments without starter were the lowest yielding fertilized plots. All other plots (80 lb ac^{-1} total application and all treatments with starter fertilizer) had higher yields. Late July rainfall provided good pollination and grainfill in 2006, and good conditions for utilization of nutrients near the soil surface. In 2007, there was a general trend for the deep band treatments to yield higher than the broadcast treatments (Figure 1). Dry conditions during late July and August limited grainfill and yield and would have limited nutrient availability and root activity near the soil surface. At Tribune, sorghum yields in 2006 were very low due to severe moisture stress. Early August rainfall in 2007 resulted in surprisingly good sorghum yields, but no response to P was seen in either year (Figure 1). Again, the rainfall which enhanced yield would also have enhanced root activity near the soil surface.

The dryland corn at Ottawa yielded substantially lower then the irrigated corn at Scandia in both years. A response to P was observed at Ottawa but there was not a clear difference due to rate or placement. In both years, the highest yielding treatment was 20 lb ac^{-1} starter, 20 lb ac^{-1} deep band (Figure 2). At Scandia, there was no response to P application in 2006. There was a response to applied P in 2007. However, no response to placement, or higher application rates was observed. With irrigation, the surface soil remained moist, enhancing root activity and availability of surface stratified nutrients. Thus no response to placement would be expected.

Conclusions

There are two key factors which should impact the response to P fertilizer placement in soils where nutrients are highly stratified: soil test P levels and the location of soil moisture. At high soil test P levels, especially when soil tests above the critical level continue to some depth, no consistent response to P would be expected. This is the situation which exists at Tribune.

However in nutrient stratified soils where the lower portions of the "plow layer" are lower fertility, when the top portion of the soil is very dry, root activity in the surface higher nutrient availability zone would be limited, and placing P into more moist soil through deep banding could be beneficial as compared to broadcasting fertilizer on the soil surface. In this study, the rainfed sites at Ottawa and Manhattan have shown a trend for higher yields with deep band treatments for sorghum and corn.

Placement didn't have an effect on yield at Scandia where irrigation provided adequate soil moisture to maintain a high level of root activity throughout the soil profile.

While to this point, data on P placement as a tool to overcome nutrient stratification is inconsistent at best, there are some patterns developing which are consistent with our basic knowledge of plant nutrition. Early work throughout the US has shown that band placement is an excellent tool to enhance the availability of P in low soil test, low fertility situations. But studies in the humid Eastern Cornbelt have shown no advantage to P placement as a means of enhancing yield and P uptake at high soil test levels where P has been strongly stratified.

Long-term studies under the drier conditions of the Western Cornbelt and Great Plains focused on nutrient stratification at moderate to high soil tests have not been done. So it will be interesting to see if the soil moisture regime common in the west will give similar results to those obtained in the Cornbelt.

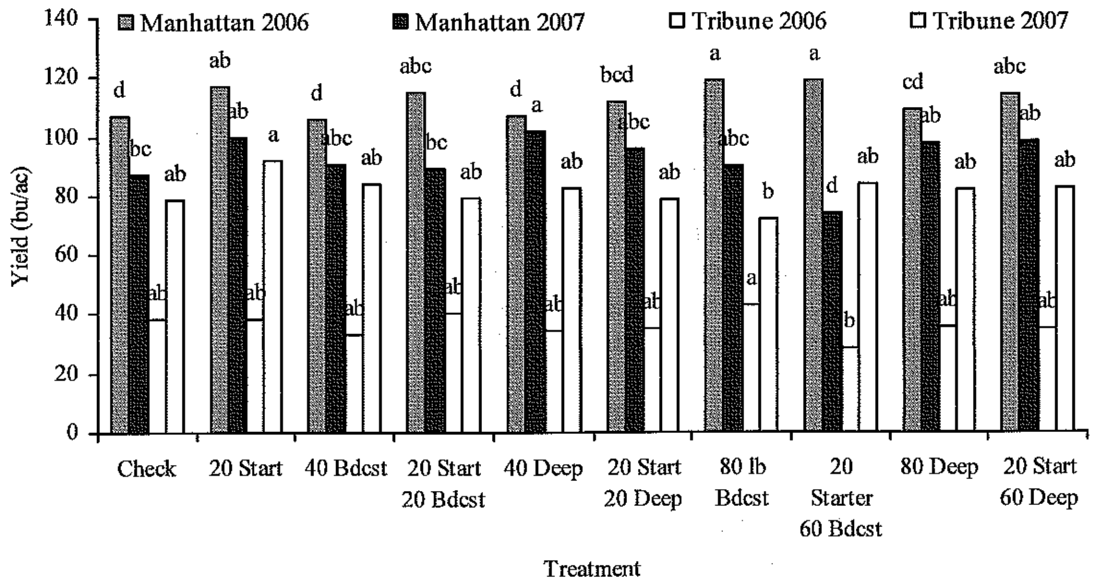


Figure 1. Manhattan and Tribune sorghum yields in 2006 and 2007. Statistical differences were calculated using *proc glm* in SAS with an alpha level of 0.1 (SAS Institute, 2004).

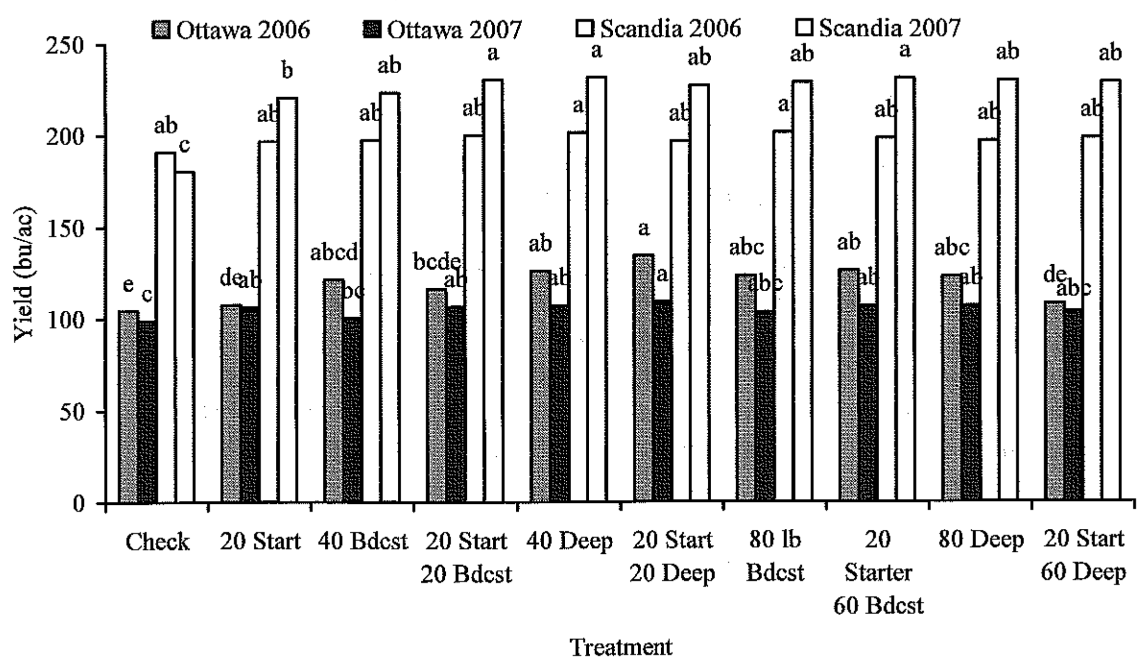


Figure 2. Ottawa and Scandia corn yields in 2006 and 2007. Statistical differences were calculated using *proc glm* in SAS with an alpha level of 0.1 (SAS Institute, 2004).

Managing pH in No-till
Dale Leikam, K-State

SOIL pH AND LIMING

When crops do not grow well, one of the first questions an agronomist is likely to ask is "What is the pH of the soil?" The reason for this question is that soil pH tells us more about a soils ability to produce crops that any other single measurement. A measurement of soil pH is like a doctor's measurement of a patient's temperature. It gives an indication something may or may not be wrong, but it does not tell the exact nature of the trouble.

What Is Soil pH?

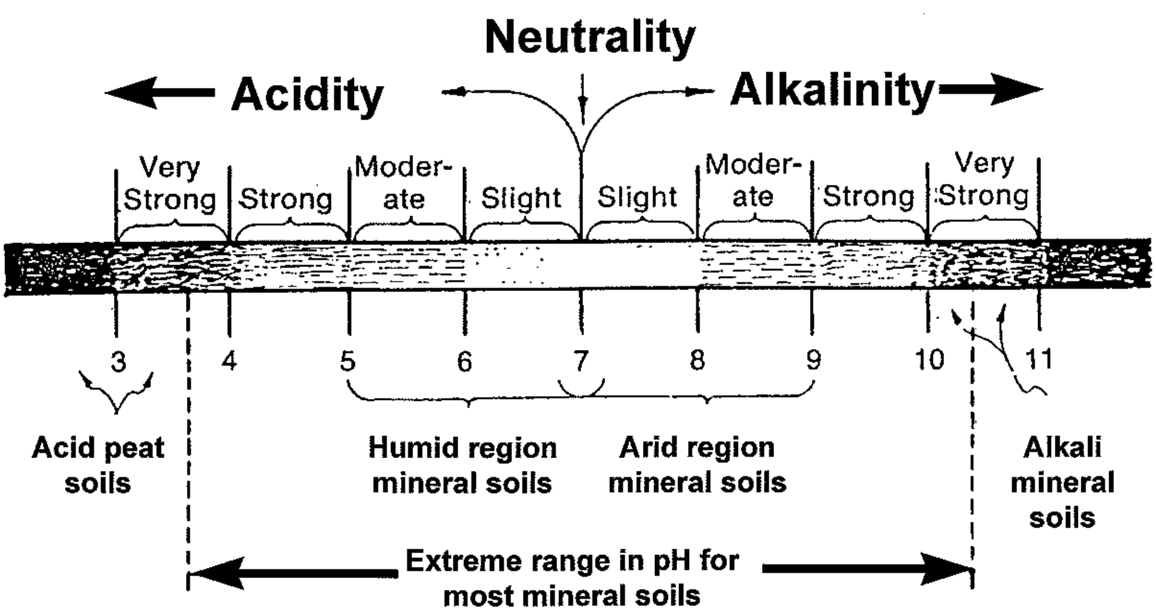
The term pH defines the relative acidity or alkalinity of a substance. The pH can vary from a minimum value of zero to a maximum of 14. The midpoint of 7.0 is considered *neutral* while values below 7.0 are *acid* and values above 7.0 are *alkaline*. The pH of most productive soils ranges from about 5.0 to 8.4

Soil pH is a measure of the H^+ concentration of the soil solution. Hydrogen ions result from the separation of water molecules (H_2O) into H^+ and OH^- ions. In acid soils H^+ out number OH^- ions, in neutral soils H^+ and OH^- exist in equal concentrations, and in alkaline soils OH^- ions predominate.

The actual concentration of H^+ is very small and difficult to express in conventional mathematical terms. For example, the H^+ concentration at neutrality is 0.0000001 or 1/million.

A more convenient form of expressing this number is 1×10^{-7} or pH 7.0. The term pH is a mathematical notation for the negative logarithm of the hydrogen ion concentration. As you might guess, the H in pH stands for hydrogen.

This makes each unit change in pH a ten fold change in acidity-alkalinity. A pH of 4 is 10 times more acid then a pH of 5 and 100 times more acid than a pH of 6 and a 1000 times more acid than a pH of 7. Even a



relatively small drop in pH from 6.0 to 5.7 results in a doubling in acidity.

Importance of Soil pH

Soil pH affects several soil chemical reactions that influence plant growth, nutrient availability, the effectiveness of fertilizers, and the performance of soil-applied pesticides. Several direct and indirect effects on plant growth and nutrition are:

- At low soil pH values, Al and Mn dissolve in amounts that are toxic to plants. When pH is above about 5.5, Al in soils remains in a solid form and is not harmful to plants. The amount of dissolved Al is 1000 times greater at pH 4.5 than at 5.5. Thus, a small change in pH below 5.0 can suddenly cause crop stunting. When Al ion concentrations reach toxic levels, roots deteriorate and appear pruned off. Some sandy soils do not contain as much Al and crops can tolerate an acid pH. Metallic ions such as aluminum, iron and manganese also react with phosphorus in acid soils to form phosphate compounds that are relatively unavailable to plant roots.

- At higher soil pH values, the availability of some nutrients decreases. Phosphorus quickly reverts to less soluble calcium phosphate compounds. The availability of several micronutrients also decreases in high pH soils.

- Soil pH affects the population and activity of soil microorganisms. These organisms decompose organic matter, releasing N, P, S and several micronutrients. The activity of organisms causing plant disease or herbicide breakdown may also be altered by pH change. In general, fungi are more active in acid soils and bacteria are more active in neutral or alkaline soils.

- The activity of symbiotic bacteria associated with legume nodules is impaired in acid soils resulting in reduced N fixation by legumes.

- In acid soils there is less Ca and Mg available for plants. Magnesium deficiencies can occur, but calcium deficiencies are very rare.

- The performance and carryover of herbicides including products in the triazine, sulfonylurea, and imidazolinone families can be affected by soil pH.

Table 1. Effect of aglime rate on hard red winter wheat yields, pH and KCl-extractable Al 4 years after application in Kingman County.

Lime Rate	Four-year Average Yield	0–6" pH	KCl-Extractable Al
lb ECC/a	bu/a		ppm
0	15	4.6	102
3,000	39	5.1	26
6,000	38	5.9	0
12,000	36	6.4	0

Initial pH—4.7, Lime Requirement—12,000 lb ECC/a, KCl-Extractable Al—94 ppm
Source: Unruh, et. al., KS Fert. Res. Report of Prog., 1986 thru 1989

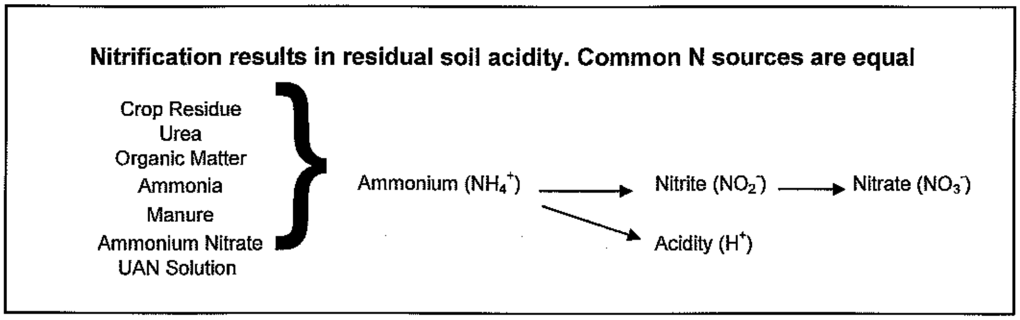
Cause of Soil Acidity:

Some soils are naturally acidic because of the composition of the parent material from which they form and/or the ecosystem in which they were formed. Rocks from which parent material originally formed vary from acidic to alkaline in reaction. Soils formed from granite, are more acidic than soils developed from sandstone or shale. Soils formed from limestone tend to have alkaline pH. Soils formed under forests tend to be more acidic than those developed under grassland. Conifers tend to cause greater acidity than deciduous trees.The majority of acid soils, however, are the result of a combination of natural and management related processes. These processes include:

<u>Leaching</u> As water moves through the soil profile, a slow but persistent acidifying effect occurs from downward movement of cations (bases) with the water. This is a very slow acidifying process that takes hundreds of years to have a significant pH change. Obviously, the impact would be greater in the higher rainfall areas compared to drier climates with little leaching. This long-term effect in the United States can be visualized as you think about more acid soils existing in the east compared to the west. Acid rainfall also can contribute to the acidification effect, but the concentration of acid in acid rainfall is relatively low and on a short-term basis is not a major impact on the soil pH.

<u>Crop removal</u>. Calcium, magnesium and potassium (bases) taken up by plants and subsequently removed through harvest can have an acidifying effect on the soil. Removal varies with crop and method of the crop harvest. Removal is greatest for high yielding forages.

<u>Microbial activity</u>. Microbial decomposition of organic and inorganic compounds that either naturally exist or are added to the soil is probably the leading cause of soil acidification. The oxidation of elemental sulfur to sulfate-sulfur is one example of an inorganic reaction. Crop residue decomposition by microorganisms produce a number of weak organic acids that tend to lower soil pH.



Soil bacteria convert ammonium (NH^+_4) to nitrate (NO_3^-) through a biochemical process called nitrification and H^+ is released resulting in soil acidification. The nitrification reaction occurs on ammonium coming from both organic (crop residue and manure) and inorganic (fertilizer) sources. Nutrient additions, therefore, contributes to the acidifying effect. Urea, ammonium nitrate, anhydrous ammonia and UAN solutions are all equal in residual acidity formation per pound of N applied. Ammonium sulfate is much more residually acidic on an applied N basis.

Correction of Soil Acidity

Acid soils contain relatively high concentrations of hydrogen ions compared to alkaline cations such as calcium and magnesium. Soil acidity is corrected by adding a liming material to decrease the concentration of hydrogen ions and increase the level of alkaline or basic cations.

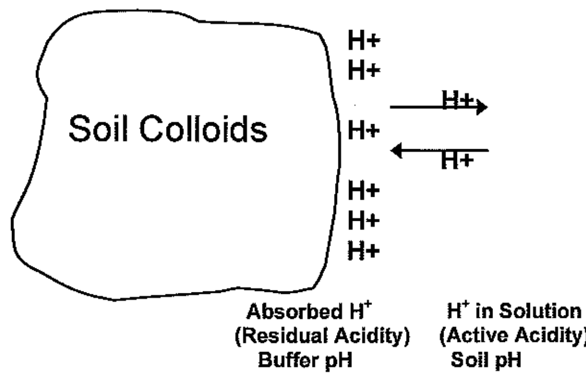
Acid-producing hydrogen ions are adsorbed on exchange sites or present in water films around soil colloids. These hydrogen ions are in constant equilibrium between the adsorbed and solution states. The concentration of H^+ ions in solution is very small relative to the H^+ adsorbed on clay and organic matter. In fact, it has been estimated that it would require less than a pound of lime to neutralize the H^+ ions in solution in a typical loam soil. The same soil might require several tons of lime to increase its pH to a desired level.

The concentration of H^+ ions in solution, though small, is very important and referred to as active acidity. Active acidity is measured by a soil pH test and is the acidity that influences the various chemical and biological reactions in the soil. A soil pH test is sometimes called a water pH.
The H+ adsorbed to the cation exchange sites serves as a large reservoir of *potential* or *residual acidity* that rapidly replaces H^+ ions in solution as they are neutralized by lime. Thus, in order to determine how much lime is required to raise the pH, an estimate of the amount of residual acidity is needed.

A few labs use texture and organic matter in conjunction with soil pH for lime recommendations. However, most labs use a chemical test using a buffer solution to determine the amount of effective calcium carbonate (ECC) necessary to raise the soil pH to a desired level.

Once a soil pH test establishes that a soil is acid and requires lime, a second test called buffer pH or buffer index is performed to estimate the total residual acidity. Buffer means resistance to change. Two acid soils with the same pH may have very different amounts of potential acidity, exchangeable Ca and Mg and consequently different lime requirements. In general, lime requirement at a given soil pH increases with the level of clay and organic matter in a soil.

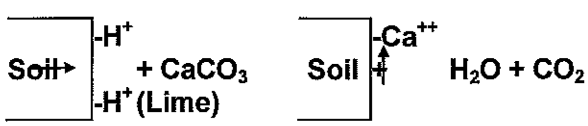
A soil pH test tells us if the soil solution is too acidic and requires liming. The buffer pH estimates the amount of total acidity present, and consequently, how much lime is required. The amount of lime required to achieve a desired pH also depends in the depth of incorporation. Most recommendations are based on neutralization of two million pounds of soil (a soil depth of about 6-7 inches for medium textured soils). If the lime is incorporated deeper, then more lime will be needed. Conversely, if lime is incorporated shallower, then less lime will be needed.



How Lime Neutralizes Acidity

As indicated previously, lime reduces soil acidity by reducing the concentration of H^+ and Al^{+++} ions and increasing the concentration of non-acidic cations such as Ca^{++} and Mg^{++}. The following illustration shows how calcium from lime replaces H^+ ions on the soil. Al^{+++} ions are also precipitated as Al_2O_3.

Not all materials which contain calcium raise soil pH. Effective liming materials must not only contain alkaline cations but they must also contain a negatively charged anion which will combine with and neutralize the H+ ions as they are displaced from the exchange sites. Carbonate is an example of an anion which combines with and neutralizes H+ while sulfate is one that does not. Calcium sulfate (gypsum) combines with H+ to produce sulfuric acid. Gypsum, therefore, is not a liming material.



Liming Materials

The Kansas Agricultural Liming Materials Act defines agricultural liming materials as products whose calcium and magnesium compounds are capable of neutralizing soil acidity. The effectiveness of a liming material in correcting soil acidity depends not only on the particular material used, but also the purity and fineness of material. It is referred to as the effective calcium carbonate equivalent (ECCE). This definition allows materials in addition to limestone ($CaCO_3$) to be considered as lime sources.
Pure, finely divided calcium carbonate has an ECCE of 100. Calcium carbonate or a mixture of calcium and magnesium carbonate (dolomitic lime) are the most common liming materials used in agriculture because they are relatively plentiful and low in cost.

Ag lime is a mixture of fine- and coarse-sized particles of calcium and/or magnesium carbonate. Finely ground particles react much faster than coarse particles since calcium carbonate is relatively insoluble and slow to dissolve. High-quality ag lime has a relatively high proportion of finely ground particles.

Fluid lime is a very finely ground calcium carbonate slurried with water. The product typically contains about 40-50% water and 50-60% finely ground calcium carbonate. The finely ground calcium generally originates from municipal water treatment plants. Advantages include a more uniform spread, quicker reaction time and utilization of a waste product. Fluid lime is equal in effectiveness to ag lime when used at comparable ECCE rates.

Table 7. Effect of rate and source of lime on soil acidity neutralization 8 months after application.

Source	Depth, inch	ECC Rate (lb/a)			
		0	1,250	2,500	5,000
			--------pH---------		
Aglime	0-3	5.1	6.0	6.6	6.8
	3-6	4.9	5.2	5.5	5.8
Fluid	0-3	—	6.4	6.5	7.2
	3-6	—	5.2	5.5	5.8

Lime applied in mid-July and incorporated by one disking and field cultivating.

*Pelletized lime is ma*de by adding a binding agent to finely ground ag-lime to obtain a high quality granular material and provides for more uniform application. It is a convenient source for blending with dry fertilizer and is well suited for use dry fertilizer applicators. Since the granules are composed of fine sized particles it also reacts relatively quickly in the soil. The final effect on soil pH is determined by its ECCE value as are all other lime sources.

When selecting a lime source, the producer needs to remember that the materials are equal in their final neutralization of soil acidity when applied at the same rate of ECCE. Thus, cost per unit of ECCE applied should be a major consideration in selecting a source. Other factors such as uniformity of spread and speed of reaction (on very acidic soils) should also be considered.

Lime Application

Since lime is relatively insoluble, it is advisable to apply the lime as far ahead of time as possible to allow time for the lime to react. Liming recommendations normally are based on an incorporation depth of 6" to 7" through the rotation. If deeper incorporation is performed, additional limestone is required in direct proportion to the depth. For shallower incorporation, lime application rates should be reduced accordingly.

For no-till systems, perennial forages and cool season grass, assume an effective liming depth of two inches. Since liming materials are only slightly soluble, surface applications will not be moved much deeper in the soil.

Table 4. Adjustment factor for aglime rate for incorporation depth.

Incorporation Depth (inch)	Adjustment Factor
3	.43
5	.71
7	1.00
9	1.29
11	1.57

Improving Your Success in No-Till

Robert N. Klein, Extension Cropping Systems Specialist

Soil water is the most limiting resource to crop production in the High Plains. Much of the High Plains adopted the summer fallow-winter wheat rotation to deal with this limitation. With herbicides to control weeds instead of tillage, and improved management of crop residue, much of the High Plains has developed more intensive cropping systems. For example, growing two crops in three years with a winter wheat-corn or sorghum-fallow rotation. For these more intensive cropping systems to be successful, there can be little tolerance for allowing weeds to use soil water.

There are four phases in a three-year cropping system involving summer fallow. The phases are: (1) winter wheat, (2) ecofallow-winter wheat stubble, (3) summer crop (corn, grain sorghum, proso millet or sunflower), and (4) pre-winter wheat fallow.

This rotation can decrease problems with winter annual weeds such as downy brome, jointed goatgrass, or feral rye. It is the least effective with jointed goatgrass, which has a longer seed life. A single cycle through the rotation usually reduces these weeds but does not eliminate them.

Weed Control in Winter Wheat (Phase I)

Controlling Broadleaf Winter Annuals in Wheat

Winter annual broadleaf weeds have the same life cycle as winter wheat and compete with the crop through most of its growing season, often causing greater yield losses than summer annual broadleaf weeds. It's estimated that if winter annual weeds are not controlled in a timely way, they can reduce wheat yields by 10 percent.

These weeds include field pennycress, blue mustard, tansy mustard, tumble mustard, and shepherdspurse. Fields should be checked early for these weeds since they are much easier to control when they are small and because the earlier they are controlled, the less impact they will have on crop yields. Once these weeds bolt or the stems elongate -- usually in late winter or very early spring, depending on weather and location -- they are very difficult to control.

Blue mustard is the most difficult winter annual broadleaf weed to control because it bolts early. Applying an appropriate herbicide when the weed is still in the rosette stage provides good control.

The bottom line is that winter wheat growers need to scout their fields in late fall or winter to determine if they will need to control winter annual broadleaf weeds in late February or early March in the case of blue mustard or in March or early April for other winter annual broadleaf weeds. Once plants begin flowering, it's too late.

If winter annual broadleaf weeds are a regular problem, change the crop rotation. Including a spring-seeded crop such as corn, sorghum, soybean, oat, proso millet, or sunflower in the rotation with winter wheat-fallow provides an additional year in which to prevent seed production and allows the soil seedbank to gradually decrease.

Controlling Summer Annual Broadleaves in Wheat

Survey your wheat fields regularly in the spring for weeds and if necessary select the herbicides or herbicide combinations best suited for the situation. Remember to always check replant options and rotation restrictions. Your herbicide selection may affect crop options next year, the following year or even three or four years later for some products – or as soon as this summer if a storm wipes out the crop.

1. **Identify** problem weeds.
2. **Spray** when weeds are small and actively growing. Spray at the proper winter wheat growth stage for the herbicide used.
3. **Use** proper spray equipment that is in good condition and not contaminated with previously used herbicides.
4. **Calibrate** the sprayer to ensure application accuracy.
5. **Read and follow** directions on the herbicide label.
6. **Know** your rotational plans to avoid herbicide carryover problems to sensitive crops.
7. **Be aware** that crop disasters such as winter injury, hail, or disease occur and previously applied residual herbicide may limit recropping options.

Summer annual broadleaf weeds include those weeds that appear above the winter wheat canopy before and at harvest. They can make harvest extremely difficult and may necessitate a "harvest aid" treatment. These treatments make harvest easier, but the real damage to the crop has already occurred. These weeds compete with the wheat for space, nutrients, soil water, and light.

Ecofallow or Winter Wheat Stubble (Phase II)

Controlling Weeds in Wheat Post Harvest

The effectiveness of post-harvest weed control is influenced by production practices associated with the previous wheat crop, such as winter wheat variety selection, fertilizer practices, row spacing, planting date, and seeding rate. Good crop residue distribution at harvest of both the long straw and fines is very important. Other factors influencing weed control include: weed size; cutting off weed tops with the combine; crop rotation; temperature when spraying; rain the day of spraying; streaks caused by sprayers, terraces, dust, straw, and chaff; and weed seed distribution. Less residue from a winter wheat crop also will make the next crop less competitive with weeds. Weeds under stress are very difficult to control. It's a general rule that for wheat grown in a three-year rotation, one can wait a maximum of 30 days after harvest to spray, but it the wheat was planted without an 11- to 14-month fallow period, it should be sprayed within 15 days after harvest. Each field should be examined separately and some will need to be sprayed before 30 days. The key is to prevent weeds from using soil water and producing weed seeds.

Split treatments have a good history of effectiveness. With the split treatment, apply the glyphosate product alone (adding surfactant, if needed, plus ammonium sulfate) as the first application in July or early August. Some glyphosate products include sufficient surfactant while many products require it to be added, so check the product label. For all glyphosate brands, add ammonium sulfate (spray grade) at 17 lb per 100 gallons of spray solution. The ammonium sulfate is the first item put into the spray tank after the water. Ammonium sulfate should be slurried first or put into only a partially (¼ to ½) full tank, then top off with rest of water. Ammonium sulfate is especially helpful when stress conditions are present. Glyphosate has been formulated as the isopropylamine, trimethysulfonium, ammonium, and potassium salts. In hard water spray carrier solutions, these counter ions are readily replaced by Ca, Mg, and Fe to form less readily absorbed salts. Adding ammonium sulfate prevents this replacement. Liquid ammonium sulfate, with or without a drift retardant, also is available.

It's difficult to recognize weed stress so it's wise to always add ammonium sulfate. Improve control by increasing the rate of glyphosate, but do not exceed label rates. Allow at least 6 hours for the glyphosate to become rainfast – and longer with some weeds. Barnyardgrass may require as much as 24 hours without rain for maximum control. With glyphosate, use a spray volume of 5 to 10 gallons per acre and don't apply on days when temperatures are expected top reach or exceed 95°F.

The second part of the split treatment should be applied in September. It should contain at least 0.55 pound per acre of atrazine and possibly Gramoxone Max (paraquat) and a surfactant, depending on the amount and size of volunteer winter wheat, downy brome of jointed goatgrass present.

The atrazine rate varies with soil and rainfall patterns. The advantage of split treatments is that they provide excellent control of volunteer winter wheat and other winter annual grasses.

Control of volunteer wheat is especially helpful in reducing the spread of wheat streak mosaic disease. Using one quart or less of atrazine before September 10 allows winter wheat to be planted 12 months later in most areas and soils. If sufficient soil water is available the following spring, corn could be planted or if moisture is limited, the field could be fallowed and winter wheat could be planted in the fall.

It's essential that you watch closely and spray at the proper time to control weeds. Most labels state that weeds must be treated before they are 6 inches tall. If weeds are under severe drought stress, wait for rain and spray about a week later.

Summer Crop (Phase III)

Control any winter annual weeds early (including volunteer winter wheat) to keep them from using soil water, producing seed and making it difficult to plant and establish the spring crop. A burndown herbicide such as glyphosate may be required. It is usually best to use the glyphosate alone. Combining it with UAN (urea ammonium nitrate) and/or preplant herbicides reduces its efficacy unless the rates of glyphosate are increased.

Some herbicides can be applied as much as 28 days before planting and still provide excellent weed control. Some also require additional herbicide to be applied at planting or before crop emergence. The advantage of early preplant is that you increase the probability of getting rainfall to activate the herbicide before weed seed germination. If rainfall does not occur, one can apply a burn down herbicide before crop emergence. Applying UAN fertilizer with these early preplant herbicides is an ideal time to apply nitrogen fertilizer. This again increases the odds that the nitrogen will be moved down into the soil profile so nitrogen will be available to the crop later in the season while the crop is getting its soil water at 3, 4 or 5 feet. Remember, any nutrient must be in soil solution to be available to the crop.

Corn

With Roundup Ready corn it is much easier to control problem weeds, such as sandbur, in no-till corn. Roundup Ready works especially well with the low population of rainfed corn and such planting practices as skip-row.

The best weed management programs involve both the use of a preplant or preemergence treatment followed with a postemergence herbicide. Glyphosate is an effective post treatment, therefore, with low weed pressure consider using a two-thirds rate of the preplant or preemergence herbicide. With medium and heavy weed pressure it is usually best to use the full rate of these herbicides. Remember, the chemical companies will not stand behind reduced herbicide rates. Also, use a postemergence herbicide to control weeds when they are small. While a delayed treatment may control 100 percent of large weeds, yields will suffer.

Grain Sorghum

Grain sorghum planted in mid-May grows slowly for the first two to three weeks. Many early season weeds including lambsquarters, Pennsylvania smartweed, common sunflower, velvetleaf and even foxtail grow faster than sorghum. For this reason early sorghum is less competitive with weeds than corn or soybean, emphasizing the need for early weed control.

Effective weed control for the first 30 days will give sorghum a head start on weeds and pay big dividends in sorghum yields. Fortunately, there are several effective preplant and preemergence herbicides registered for use in sorghum. It is important to target annual grass weeds with a preplant or preemergence treatment as postemergence options are limited. Essentially all sorghum seed is now treated with a safener required for use of most preplant or preemergence herbicides. For postemergence herbicide application rate, sorghum and weed growth stage, and spray additives are all important in attaining maximum performance.

Proso Millet

Weed control in growing proso millet is currently limited to 2,4-D amine, 2,4-Damine + Aim (carfentrazone), 2,4-D amine + dicamba or Peak (prosulfuron). Proso can easily be injured by 2,4-D and/or dicamba. Add nonionic surfactant with treatments that include Aim (prosulfuron) or Peak (prosulfuron). Herbicides should be applied when proso is in the 3- to 5-leaf stage. There is no control for grassy weeds in proso, so pre-crop weed control and crop rotations that reduce these weed pressures are very beneficial. It is important to remember that swathing makes weeds a much less serious harvest problem than in direct-harvested crops.

Sunflower

Sunflower is usually planted later and at lower densities than many other crops. It is slow to establish and good stands are difficult to obtain. Weeds that emerge and establish during this time can be very competitive and reduce sunflower yield potential tremendously; however, sunflower is a strong competitor when stands are good and even with weeds that emerge three or more weeks after sunflower emergence if the crop stand is good and even. Therefore, maintaining weed-free sunflower for the first three to four weeks after planting will minimize yield losses from weeds.

Pre-Wheat Fallow (Phase IV)

Reducing Tillage During Fallow Weed Control

The pre-wheat fallow period, commonly referred to as summer fallow, has traditionally been managed with tillage. Depending on rainfall amount and distribution, this has required four to eight tillage operations in most years. Each of these tillage operations can result in a soil water loss of ⅓ to ½ inch or more and the destruction of crop residue. Table 1 shows the benefits of surface straw residue on the amount of water stored and the surface soil temperatures attained during a summer fallow period with limited precipitation.

We classify stored soil water as being 100 percent effective as a source of soil water for plants. In the spring when the soil is moist and air temperatures are low to moderate, it is impossible to kill weeds with tillage unless the weeds are buried, which also destroyed the crop residue. About 89 percent of the water in snow that is captured is stored in the soil. A Colorado study even found that 70 percent of their snow came when the ground was not frozen and could be captured.

Table 1. Benefit of surface straw residue during summer fallow.

Straw position	Water stored (inches)	Soil temp (°F)
Bare soil	0.58	118
Straw flat	2.89	107
1/4 Standing, 3/4 Flat	2.35	108
3/4 Standing, 1/4 Flat	3.02	90

Spring is the most effective time to use herbicides instead of tillage to control weeds. When spring tillage buries the weeds, it also buries any crop residue. Some research has found that as rainfall events become less frequent in mid to late summer, soil water storage during summer fallow may be improved with a single shallow tillage operation compared to using no-till exclusively. The tillage operation can improve rainfall infiltration into the soil surface. This improvement in soil water storage does not occur with long term no-till with controlled traffic and crop residue with good coverage of the soil surface.

Most herbicide applications during fallow will eliminate two tillage operations. The most economical herbicide treatment is to use glyphosate with or without 2,4-D, depending on the weed species present. Always put spray grade ammonium sulfate at 17 lbs per 100 gallons of spray solution in the tank before adding glyphosate. Surfactant may need to be added if the glyphosate does not contain a surfactant or enough surfactant. The surfactant is the last item added to the tank.

Reduced glyphosate costs make herbicides an even more likely choice for weed control throughout the fallow period. Use a drill capable of seeding into the crop residue. If the summer is dry and hot, the seeder may not be able to penetrate the soil deep enough to place the wheat seed in firm moist soil. This can be resolved by using one tillage operation which maintains the crop residue in late June to early July, depending on the weather and area in the state, to help eliminate the potential soil penetration problem. Using no-till from year to year will help build organic matter and soil structure, making this less of a problem.

If there is little or no crop residue, such as when the previous crop was removed for hay or silage, it won't work well to use herbicides for weed control for the entire fallow period. If you need to remove a crop for hay or silage, leave 6-8 rows of residue 12-20 rows apart, depending on the height of the crop, to protect the soil and crop residue from wind and erosion to trap snow.

Water Rights and Depleting Water

Wayne Bossert

Water Rights & Depleting Water ......

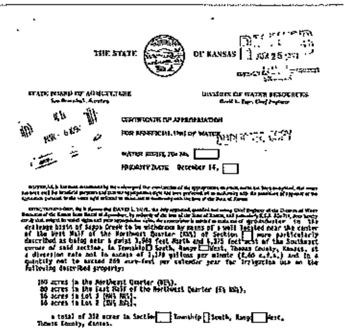
Water Rights:

- Kansas is a Prior Appropriation state
- Every use of water except domestic use – regardless of amount – requires a water right
  - Single household use for household purposes
  - Water use of small businesses (restaurant, church, motel, school, prison, etc.) for household purposes if less than 1.5 AF
    - Drinking, restrooms, bathing, cooking, cleaning & fire protection
      - Water from a dry hydrant or water well installed within 1000 feet of a house or business
    - watering livestock, poultry and domestic animals of the house or farm
    - Irrigation of lawns, gardens & orchards less than 2 acres
    - Ponds less than ½ acre in size if they are landscape elements 300 feet or less from a house
- Water Rights are approved by DWR after application & review
  - An application Review is subject to many criteria
    - If water is available without impairment; app in good faith?; Well spacing; Waste;
    - DWR Regs; GMD regs (if within a GMD); Reasonableness; Public Interest; Beneficial use; etc.

Water Rights & Depleting Water ......

Water Rights:

- A Water Right is a very Specific, Property right to the use of the state's water
  - A source of water
  - A maximum rate & quantity / yr
  - A specific type of use
  - A specific place of use
  - A specific point of diversion(s)
  - A set perfection period


THE STATE OF KANSAS

CERTIFICATE OF APPROPRIATION

Water Rights & Depleting Water ......

Water Rights:

- An approved water right is given:
  - 1 year to complete the well;
  - a minimum of 5 years to perfect the use of the approved rate and amount;
- Certificate is issued for the maximum rate and amount actually used beneficially in the time
- A water right can be changed in 3 ways – only with application and approval by DWR:
  - change place of use;
  - change point of diversion;
  - change use made of water;
- Water right owner can also voluntarily reduce any of the above or forfeit the entire right

Water Rights & Depleting Water ......

Depleting Water:

GMD 4 – Wells & Well development

- 3.11 million acres (4,850 square miles)
- 3,541 permitted, high capacity wells
- 384,000 Acres Irrigated (2002)
- 514,708 Acrefeet Pumped (2002)
- 861,247 Acrefeet Appropriated

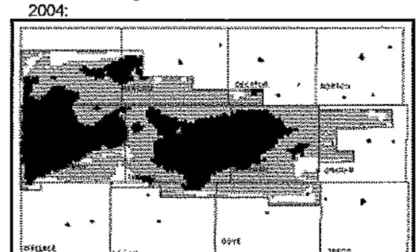
- Average AcFT pumped: 412,000 AF
- Average Long Term Recharge: 150,000 AF

- Average Annual Change in Saturated Thickness: -.6 feet

Water Rights & Depleting Water ......

Depleting Water:

GMD 4 - Change in saturated thickness - 1965 - 2004:



Red = 35 feet & more Blue = 15 ft to 35 ft Green = Less than 15 ft

Water Rights & Depleting Water ......

Depleting Water: What's Being Done?

1974: Legislature passed the GMD Act – allowing locals to form a management district and manage groundwater as they wished – so long as it was consistent with state law.
1976: NW Kansas GMD 4 was formed.
1978: GMD 4 started with a ½ mile well spacing and a no irrigation tailwater policy.
1980: First GMD to require meters – but only on all new/replacement wells
1980: replaced the well spacing with a 2-mile circle evaluation set at not exceeding 2%/year.
1987: replaced 2%/year with 1%/year
1991: replaced 1%/year with safe yield – maximum of 335 AF out of any 2-mile circle
2001: Began the Enhanced Management Protocol Planning
2002: Reduced the 25 AF small use exemption to 15 AF and only 1 per mile
2004: Eliminated the 15 AF exemption by requiring an offset
2005: Required meters on all wells – 4-year phase in – completed by 2009
2006: EQIP, WTAP, Conservation Foundation programs offered in HPA to set-aside water rights
2007: Established 6 High Priority Management Areas based on declines & water use

Water Rights & Depleting Water ......

Depleting Water: What's Being Done?

Enhanced Management Protocol Process

Implemented under guidance of the State Water Plan

The direction is: reduce water use and slow the decline rate of the Ogallala

Has each GMD and the DWR:

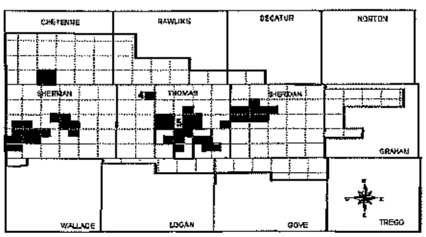
- Identifying their High, Medium and Low priority areas
- Developing enhanced management plans for the High Priority areas

Water Rights & Depleting Water ......

Depleting Water: What's Being Done?

Enhanced Management Protocol Process

GMD4 High Priority Areas
Adopted March 6, 2007



Ten Crop Sequences, Transition to No-till

Rob Aiken and Dan O'Brien

K-State Northwest Research—Extension Center

Introduction

Available water frequently limits productivity in semi-arid cropping systems. The wheat-fallow system accumulates water over a two-year period, producing a single wheat crop. Tillage, providing weed control, often leaves the soil exposed to evaporative and erosive forces. Frequently, more precipitation is lost to evaporation than used by a growing wheat crop. More intensive crop sequences use feed grains (corn, grain sorghum) and oilseeds (spring canola, soybean, sunflower) to reduce evaporative losses in fallow periods and increase crop access to precipitation. The objective of this study is to compare water use, grain yield, biomass productivity, and economic returns for ten cropping sequences.

Procedure

Cropping sequences (Table 2) cover three-year cycles of wheat, feed grain (corn or grain sorghum) and oilseed (sunflower, soybean, canola) or fallow; as well as wheat-fallow (two-year cycle) and wheat-corn-sunflower-fallow (four-year cycle). Each phase of a sequence is present each year, in triplicate sets of plots. Thus, cropping sequences represent 1:2, 2:3, 3:4 and 3:3 (crop harvest:years in cycle) cropping intensities.

Crop management is intended to minimize evaporative loss of water, maximize grain productivity and maximize soil water recharge. Full-season, adapted feed grain cultivars are planted at conventional periods; short-season oilseed cultivars are planted early in continuous cropping sequences to permit wheat planting following harvest. Cultural practices (Table 1) are modified at beginning of each three-year cycle to reflect technology advances.

Crop water use is measured by precipitation and change in soil profile water content from emergence to flowering to harvest (physiological maturity). Yield components (stand, mid-vegetative and harvest; flowering units, seed weight) and above-ground biomass are hand-sampled at maturity. Seed yield is also measured by machine-harvest, using a plot combine (platform or corn header). For conditions with poor stands, yield potential is estimated from hand-harvested samples. Yields are adjusted to standard moisture contents. Annualized crop water use, grain yield, or biomass computed as the average among all phases (including fallow) of a given sequence, providing a uniform basis for comparing water use and land productivity among crop sequences.

Results

The study was established in 2000, planted into uniform wheat stubble. Thus, the 2002 harvest was the first year reflecting crop sequence effects for three-year cycles. Two complete cycles of the three-year sequences are represented by 2002-2007 results. Crop water use, grain yields and biomass productivity are presented (Table 2) for each phase of the crop sequences, averaged over years. Annualized values represent the sum of each phase, divided by number of years in the crop sequence. Some trends observed during these drought years include the following.

- Land productivity varies with rainfall, among years.
- Wheat productivity benefits from summer fallow.
- Grain sorghum productivity exceeds corn when limited by water.

- Continuous cropping increases the fraction of precipitation used by crop.
- Stand establishment, timing and amounts of water limit oilseed productivity.

Grain yield was closely related to above-ground biomass (Figure 1). Annualized productivity, averaged over all growing seasons indicates that the wheat-grain sorghum-fallow sequence provided greatest land productivity. Land productivity for the wheat-corn-fallow sequence exceeded that of continuous cropping with grain sorghum and either spring canola or soybean.

Table 1. Typical crop cultural practices for crop sequence study, 2002 – 2007.

Crop	Cultivar	Seeding	Fertilizer	Pesticide/Weed Control
Wheat	Jagger	90#/A	70#N, 30#P	Starane 0.5 pt/A
Corn	CA 6920 Bt, Ottilie 5170RR, DKC50-20 RR2/YGCB	18,500 seeds/A	70#N, 30#P	Roundup UM 24 oz/A
Grain Sorghum	CA 737, DK-44	40,000 seed/A	70#N, 30#P	Roundup UM 24 oz/A[1] Starane 8 oz/A or Clarity 8 oz/A[2]
Canola	Hyola 401, Hyola 357RR	11#/A	70#N, 30#P	Treflan 1.5 pt/A Gaucho seed treatment Capture 2EC 2.5 oz/A Roundup Ultra 16 oz/A[1]
Soybean	IA 1008, Macon KS4704RR	175,000 seeds/A	70#N, 30#P	Raptor 4 oz/A Roundup Ultra 16 oz/A
Sunflower	SF 187, Myc 8N429CL	18,000 seeds/A	70#N, 30#P	Lorsban 15 2#/A Roundup RT 24 oz/A Beyond 4 oz/A Spartan 3 oz/A
Fallow, No-Till	--	--	--	4X Roundup Ultra 16 oz/A[3]
Fallow, Red. Till	--	--	--	4X Undercut with Sweep Plow

[1] When weeds were present prior to planting.
[2] Broadleaf control, as needed.
[3]Ammonium sulfate was added (17 lb/ 100 gal first application, 10 lb/ 100 gal later applications) to Roundup Ultra fallow applications, but not in tank mixes.

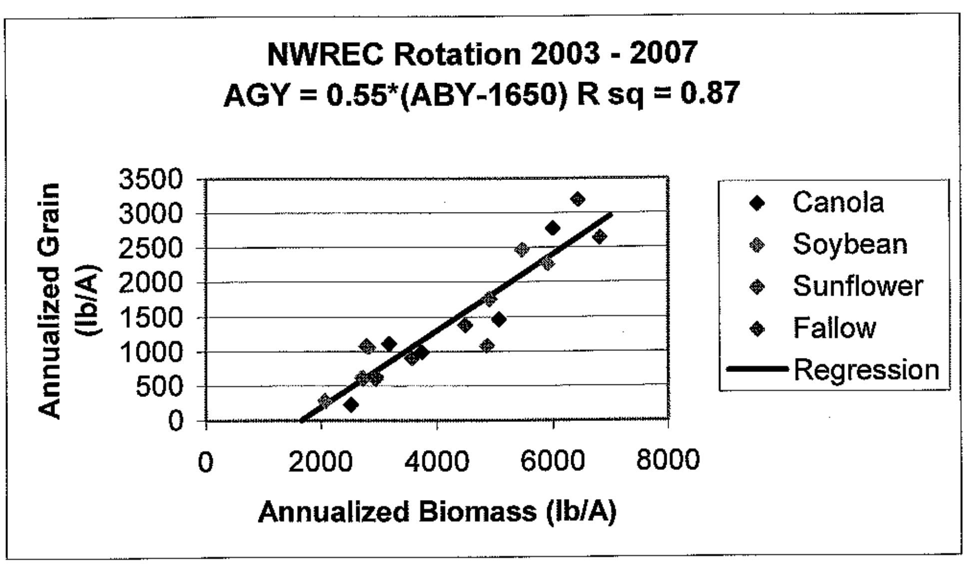


Table 2 Crop Sequence Effects on Water Use, Biomass and Grain Yields, 2002 - 2007

Rotation	Wheat Phase		Feed Grain Phase		Oilseed Phase		Annualized
Crop Water Use							
WW-C-Can	9.02		13.53		8.16		10.67
WW-C-Soy	8.84		12.8		12.99		11.52
WW-C-Sun	8.17		12.54		10.78		10.72
WW-C-Fal	12.85		13.74		0		8.77
WW-GS-Can	8.75		14.89		8.21		11.05
WW-GS-Soy	8.08		13.80		13.43		11.8
WW-GS-Sun	8.04		12.97		10.42		10.74
WW-GS-Fal	10.88		14.83		0		8.49
WW-Fal	10.98		0		0		5.49
WW-C-Sun-Fal	10.81		14.11		11.86		9.38
Biomass Yield (lb/A)							
WW-C-Can	4137		4190		1550		3259
WW-C-Soy	3484		3846		1518		2920
WW-C-Sun	3060		4026		1763		2920
WW-C-Fal	6883		5428		0		4062
WW-GS-Can	3937		7130		1189		4044
WW-GS-Soy	3271		6879		1527		3854
WW-GS-Sun	3401		5787		1640		3573
WW-GS-Fal	6814		8100		0		4922
WW-Fal	6302		0		0		3151
WW-C-Sun-Fal	6306		5596		2565		3617
Grain Yield							
	(lb/A)	bu/A	(lb/A)	bu/A	bu/A	(lb/A)	(lb/A)
WW-C-Can	1096	18.3	1390	24.8		395	951
WW-C-Soy	984	16.4	1362	24.3	10.8	649	988
WW-C-Sun	697	11.6	1393	24.9		350	805
WW-C-Fal	2243	37.4	1997	35.7		0	1400
WW-GS-Can	968	16.1	2824	50.4		249	1333
WW-GS-Soy	851	14.2	2569	45.9	10.7	643	1341
WW-GS-Sun	761	12.7	1892	33.8		293	972
WW-GS-Fal	2240	37.3	3296	58.9		0	1827
WW-Fal	2435	40.6	0			0	1217
WW-GS*-Sun-Fal	1916	31.9	1845	32.9		671	1108

WW = Winter Wheat (13% moisture basis, 60 lb/bu), C = Corn (15.5% moisture basis, 56 lb/bu), Can = Canola (10% moisture basis, cwt), Soy = Soybean (13% moisture basis, 60 lb/bu), Sun = Sunflower (10% moisture basis, cwt), Fal = Fallow, GS = Grain Sorghum (12.5% moisture basis, 56 lb/bu).

Annualized is the sum of the phases for a crop sequence, divided by number of years in the crop sequence.

*Feed grain was corn in 2002.

Economic Comparison of Crop Sequences (Cropping Systems)

An economic analysis of the relative profitability of these alternative cropping systems was performed (Table 3). Net returns for canola, soybeans and sunflower were combined in this cost-returns analysis for continuous crop sequences and are referred to as "oilseeds". In other words, instead of having separate results for wheat-corn-canola, wheat-corn-soybean and wheat-corn-sunflower rotations, the results of these three rotations are combined into one wheat-corn-oilseed rotation. The same applies for continuous cropping sequences involving grain sorghum. The oilseed enterprises were combined to avoid research plot management issues associated with inclusion of oilseeds in the study.

Crop input cost estimates in Table 3 were developed from Table 1 using recent crop budget guides from K-State Research and Extension, the University of Nebraska-Lincoln and other sources where needed. Per unit cost estimates of seed, fertilizer, herbicides and insecticides were used. Current estimates of current field operation costs were taken from Kansas Agricultural Statistics. Field operation costs used in this analysis included those for planting / seeding; application of fertilizer, herbicides and insecticides; tillage; harvesting and hauling of grain. Grain prices for the 2002/03 through 2007/08 marketing years for wheat, corn, grain sorghum, canola, soybeans and sunflowers were gathered from United States Department of Agriculture sources.

Decisions of whether to harvest crops in a particular year were made in the following manner. If the revenue from crop (yield times grain price) was greater than or equal to the total harvesting and hauling cost of the grain, then the crop was harvested. Returns over total harvesting cost were then applied toward covering the rest of crop production costs. Conversely, if crop revenue was less than total harvesting cost, then crop enterprise financial losses were minimized by not harvesting the crop. The proportion of years that individual crops were harvested by crop rotation is provided in Table 3.

Results in Table 3 indicate that for the 2002-2007 period, average annual net returns for the Wheat-Grain Sorghum-Fallow (W-GS-F) crop rotation were the highest among among the crop rotations considered in this study, equaling $35 per acre. Average net returns for the Wheat-Fallow (W-F) rotation averaged $31 per acre. Net returns for the Wheat-Corn-Fallow (W-C-F) crop rotation averaged $14 per acre, the only other rotation in this study with positive net returns. The Wheat-Grain Sorghum-Sunflower-Fallow (W-GS*-Sun-F) rotation averaged a net loss of $12 per acre, over the 2002-2007 period, followed by Wheat-Grain Sorghum-Oilseed (W-GS-Oilseed) with a loss of $16 per acre annually. Average returns for the Wheat-Corn-Oilseed (W-C-Oilseed) rotation was a negative $32 per acre.

Returns for the W-GS-Oilseed, W-C-Oilseed, and W-GS*-Sun-F rotations may have been negatively affected by production problems affecting the oilseed crops in the rotation. The percentage of times that these oilseed crops were actually harvested (i.e., revenues greater than harvest and hauling costs) ranged from 19% to 28% these three rotations. For wheat enterprises in this study, it is noteworthy that for W-C-F, W-GS-F, W-F and W-GS*-Sun-F rotations, wheat returns met the minimum harvest returns and therefore were harvested in 100% of the cases in this study. Conversely, in continuous W-C-Oilseed and W-GS-Oilseed rotations, wheat enterprises met the minimum harvest threshold 69% and 70% of the time, respectively. The proportion of time that feedgrains (corn and grain sorghum) are harvested may also have been affected by whether or not they were involved in a continuous crop rotation with oilseeds or not. Corn was harvested in a W-C-F rotation 56% of the time, while it was

Table 3. Crop-Sequence Costs and Returns, 2002-2007

	Wheat				Feedgrains				Oilseeds			Fallow	Rotation
Rotation	Yield Bu /ac	Prodn Cost $/ac	Hvst Cost $/ac	Net Return $/ac	Yield Bu /ac	Prodn Cost $/ac	Hvst Cost $/ac	Net Return $/ac	Prodn Cost $/ac	Hvst Cost $/ac	Net Return $/ac	Fallow Cost $/ac	Net Return $/ac
W-C-F	37.4	$56	$24	$72	35.7	$68	$28	$17	NA	NA	NA	$47	$14
% Harvest			100%				56%						
W-C-Oilseed	15.4	$56	$19	($5)	24.6	$68	$26	– $11	$93	$21	–$79	NA	– $32
% Harvest			69%				52%			19%			
W-GS-F	37.3	$56	$24	$79	58.9	$66	$30	$74	NA	NA	NA	$47	$35
% Harvest			100%				72%						
W-GS-Oilseed	14.3	$56	$19	– $8	43.4	$66	$27	$40	$93	$21	– $80	NA	– $16
% Harvest			70%				61%			17%			
W-F	40.6	$56	$25	$88	NA	NA	NA	NA	NA	NA	NA	$26	$31
% Harvest			100%										
W-GS*-Sun-F	31.9	$56	$23	$57	33.0	$66	$24	$7	$93	$21	– $64	$47	– $12
% Harvest			100%				61%			28%			

Table 4. Statistical Analysis of Crop Sequence and Year Affects on Net Returns, 2002-2007

	Crop Sequence Coefficients ($/Acre)	Standard Error of Coefficients ($/Acre)	t-Statistic for Statistical Analysis	P-Value (1) (% Probability that Factor is NOT Significant)
Model Intercept (W-F in Year 2002)	– $5.36	$8.53	– 0.64	53.1%
Wheat–Corn–Fallow	– $16.94	$9.85	– 1.72	8.7%
Wheat–Corn–Oilseed	– $62.53	$8.04	– 0.92	**0.0%
Wheat–Grain Sorghum–Fallow	+ $4.40	$9.85	+ 0.45	65.5%
Wheat–Grain Sorghum–Oilseed	– $46.55	$8.04	– 5.79	**0.0%
Wheat–Grain Sorghum*–Sun–Fallow	– $42.57	$9.85	– 4.32	**0.0%
Year 2003	+ $11.16	$7.63	+ 1.46	14.5%
Year 2004	– $10.62	$7.63	– 1.39	16.6%
Year 2005	+ $39.70	$7.63	+ 5.21	**0.0%
Year 2006	+ $33.95	$7.63	+ 4.45	**0.0%
Year 2007	+ $143.40	$7.63	+ 18.80	**0.0%

(1) "**" & "*" represent t-test results at the 1% & 5% levels of statistical significance, resp.; $R^2 = 0.89$, Adj $R^2 = 0.80$

harvested in W-C-Oilseed rotations 52% of the time. Grain Sorghum was harvested in a W-GS-F rotation 72% of the time, while in both W-GS-Oilseed and W-GS*-Sun-F rotations it was harvested 61% of the time.

Statistical Analysis of Crop Sequence and Year Effects

The results of a statistical analysis of the impact of crop sequence and year affects upon net crop rotation returns are presented in Table 4. The impact of various crop rotations and years are compared to the net returns of the Wheat-Fallow (W-F) crop rotation in the 2002 crop year. During 2002/03, W-F rotations had a net return of – $5.36 per acre.

After accounting for crop year affects, the W-GS-F and W-C-F rotations were not statistically different from the W-F rotation (Table 4). However, the W-C-Oilseed, W-GS-Oilseed, and W-GS*-Sun-F rotations had significantly less average income relative to W-F.

Year by year impacts on net returns relative to 2002 (after adjustment for cropping systems) varied considerably, but were positive and significant for year 2005 (+ $39.70 per acre), year 2006 (+ $33.95 per acre), and year 2007 (+ $143.40 per acre). Years 2003 and 2004 had small positive and negative impacts, respectively, upon net returns per acre that were not statistically significant.

Summary

As stated in the introduction, the objective of this study is to compare water use, grain yield, biomass productivity, and economic returns for ten cropping sequences. Preliminary results indicate that Wheat-Grain Sorghum-Fallow and Wheat-Fallow rotations out performed other crop sequences examined in the study, with the Wheat-Corn-Fallow crop rotations also providing positive net returns.

Future work may include additional analysis of the impact of crop insurance coverage tools upon the financial net returns of these rotations, accounting for both the annual costs and returns from crop insurance coverage. Over the long run, if crop insurance is rated in an actuarially correct manner, the annual costs would balance out or be offset by the average annual returns.

In regards to the impact of including oilseeds in these rotations, more attention needs to be given to understanding the affect of close, in-field management of canola, soybean, and sunflower pests upon oilseed yields and net returns. Even with these acknowledged issues, the impact of oilseeds in rotation upon succeeding crops (i.e., wheat, corn, grain sorghum) is useful to understand.

DRAFT

Droplet Size Calibration – A New Approach For Effective Spraying

Application Technology Series

***Robert E. Wolf,** Associate Professor and Extension Specialist, Biological and Agricultural Engineering Department, Kansas State University, Manhattan, Kansas*

Proper calibration of a sprayer to achieve accurate and efficient application of crop protection products has long been a goal for a prudent spray operator. The calibration steps are taken to ensure that the desired amount of spray material is being dispersed according to label recommendations. The steps taken to properly calibrate the sprayer will involve a calculation to determine the nozzle flow rate required to deliver the recommended carrier application volume in gallons per acre (GPA). The formula used, $GPM = \frac{GPA * MPH * W}{5940}$, will incorporate the desired GPA, an appropriate ground speed (MPH), and nozzle spacing (W - inches) on the boom resulting in gallons per minute (GPM) flow rate per nozzle. The proper orifice size for the nozzle type is then selected from the appropriate chart and placed on the sprayer at each nozzle location. Then the spray process must take place maintaining the calibrated speed and pressure to obtain the desired application volume.

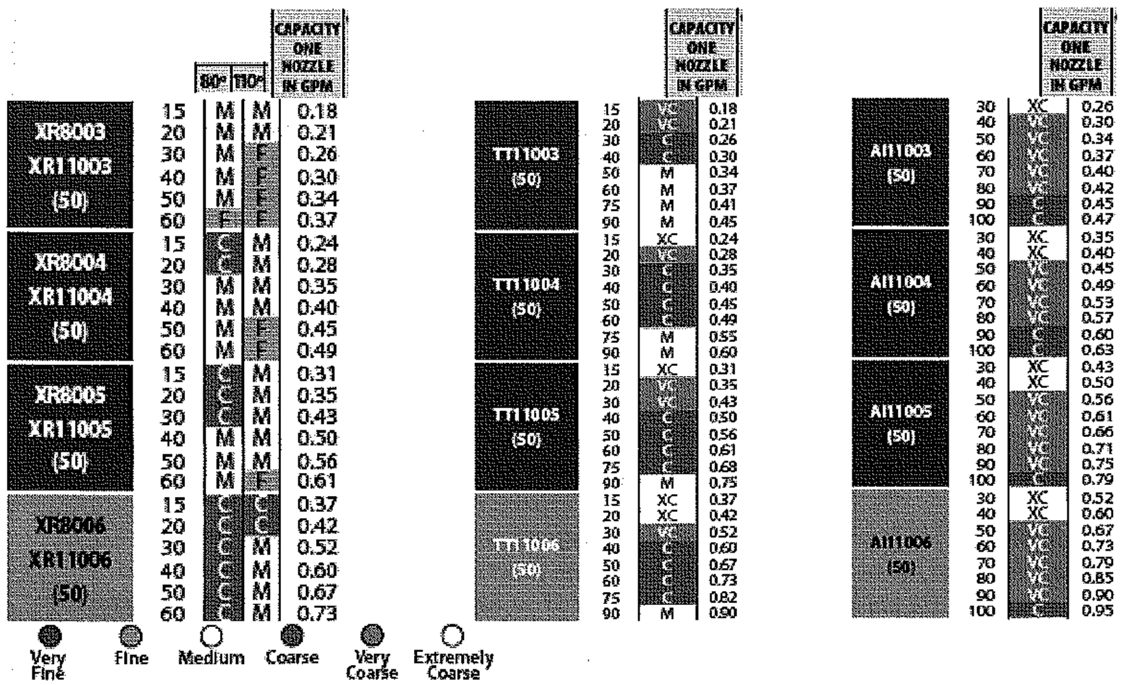
Most applicators are familiar with how to use flow rate charts from spray equipment catalogs and web sites to determine the nozzle orifice size needed as described above. Applicators are also comfortable in making those applications with the benefit of an automatic rate controller to help improve the uniformity of application volume across the field. However, a properly calibrated sprayer does not guarantee the application will achieve its highest level of efficacy or minimize drift. The next step in calibration is designed to achieve this, but is one that most applicators are not yet familiar. This calibration step requires applicators to review droplet size charts to choose nozzle types and pressure levels that will meet a specified droplet classification listed on the label. The droplet size created by a nozzle becomes very important when the efficacy of a particular plant protection product is dependent on coverage, or the minimization of material leaving the target area is a priority. Droplet specifications given on the label are provided to guide applicators in selecting how to best apply that material. Thus, consulting the nozzle manufacturers' droplet sizing charts is ESSENTIAL. Applicators should also remember the effect of changing speed on controller based applications. Major speed fluctuations will cause pressure adjustments that while balancing the GPA may shift the droplet spectrum resulting in possible off-label applications.

To help growers select nozzles according to droplet size, spray equipment manufacturers are including drop size charts with their respective catalogs and web sites. These charts classify the droplet size from a given nozzle at various pressure levels according to a standard set up by the American Society of Agricultural and Biological Engineers (ASABE). The standard (S-572) rates droplets as very fine, fine, medium, coarse, very coarse, and extra coarse. Droplet size categories are color-coded as shown in the adjacent chart.

ASABE Standard S-572 Spray Quality Categories	
category	color
Very Fine (VF)	red
Fine (F)	orange
Medium (M)	yellow
Coarse (C)	blue
Very Coarse (VC)	green
Extra Course (EC)	white

As an example, for a single nozzle application, to achieve 10 GPA at 12 MPH with a 20-inch nozzle spacing, a "04" orifice would be required (ie. 8004, 11004) to deliver the 0.40 GPM flow rate (10 GPA * 12 MPH * 20-inch nozzle spacing divided by 5940). Regardless of the nozzle type selected, the pressure for this orifice scenario would need to be 40 PSI to deliver the correct GPA, resulting in a medium droplet with the XR* nozzle (either 8004 or 11004), a coarse droplet with the TT* nozzle, and an extra coarse with the AI* nozzle (see charts below).

Obviously the nozzle type selected for this application scenario will influence coverage as well as drift. For some fungicide and/or insecticide application scenarios the medium/fine option would be very close to the desired specifications for adequate coverage and efficacy. However, when applying certain herbicides, a larger droplet spectrum may be essential to minimize the drift potential.



An influencing factor then becomes the necessity for applicators to have a good knowledge of the 'mode of action' for the crop protection product being used. It is commonly thought that a systemic material such as glyphosate can work well with a medium, coarse, or maybe even a very coarse droplet spectrum while a contact material such as paraquat will need a droplet spectrum promoting more leaf coverage, ie. medium.

A close review of the flow rate and droplet category charts would reveal that several nozzle options could be acceptable for various application scenarios as long as the specified droplet classification is followed. In the above example, selecting a larger orifice, the 11005 at approximately 26 PSI, would deliver the correct application volume (0.40 GPM), but would alter the droplet spectrum significantly; the XR would remain medium for the 11005, but would change to coarse with the 8005. With the "05" orifice, the TT becomes very coarse and the AI is now extra coarse. In fact the AI would not be recommended since it falls below its minimum operating pressure. Shifting to a smaller orifice, the 11003, results in the XR being fine for both fan angles and would not be recommended because the 70 PSI exceeds reasonable levels. The TT11003 would have a medium droplet spectrum, but at 70 PSI is approaching its higher use limit. The AI11003 would become very coarse and can be recommended at 70 PSI. In the above scenarios, the low and high pressure concerns are all related to lack of coverage or increased drift potential.

Droplet size charts for other nozzle types may differ from the examples above. Learning to use these droplet sizing charts is absolutely essential for proper pest control product application. It is also highly possible that certain nozzle types may not meet the label specified droplet spectrum. All nozzle manufacturers' provide this information for the nozzle types they market.

*Brand names appearing in this document are for identification and illustration purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned.

IMPROVING CAPTURE and USE of WATER

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Cover Your Acres Winter Conference
22 and 23 January 2008
Oberlin, Kansas

KEY MANAGEMENT FACTORS to IMPROVE the CAPTURE and USE of WATER in CROP PRODUCTION.

Dryland and Irrigated

1. Maximize the use of crop residues
2. Minimize the use of tillage
3. Fracture tillage pans or soils compacted by traffic

Limited Irrigation

1. Use selective timing of limited irrigation
2. If preplant irrigation is used (more likely with low-capacity wells) – water content of the soil profile is extremely important

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"We've developed two generations of Spartan Corn," Sticklen says. "Both corn varieties contain the enzymes necessary to break down cellulose and hemicellulose into simple sugars in their leaves. This will allow for more cost-effective, efficient production of ethanol. In the future, corn growers will be able to sell their corn stalks and leaves as well as their corn grain for ethanol production. What is now a waste product will become an economically viable commodity."

When stored in the cell wall areas, the corn-produced cellulase does not

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CROP RESIDUE is not WASTE

Crop Residue is not "unproductive" – (producing little or no profit or gain)

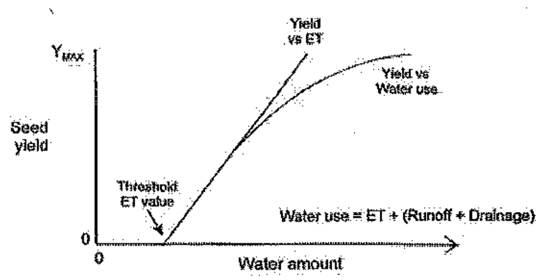
Crop Residue is not "superfluous" – (unnecessary or not needed)

Crop Residue is not "worthless" – (of no use, importance, or value)

BENEFITS to the Crop-Soil Environment from MORE RESIDUE – LESS TILLAGE

1. Reduced soil losses from wind and water erosion – using crop residues to protect the soil surface is the single most effective way to control erosion
2. Improved soil quality components – improved soil chemical and physical properties are gained primarily because of increased organic matter content
3. Improved water capture and storage – residue serves to decrease evaporation losses and to improve (maintain) infiltration rates

CROP YIELD vs. WATER RELATIONSHIPS (patterns)



CROP YIELD vs. ET RELATIONSHIPS (values)

Crop	Max. ET for full-season variety	Threshold ET	Slope of yield vs. ET	Slope of long-term yield vs. ET *
Corn	25 in.	10.9 in.	16.9 bu/a./in.	13.3 bu/a./in.
Soybean	24 in.	7.8 in.	4.6 bu/a./in.	3.8 bu/a./in.
Grain sorghum	21 in.	6.9 in.	12.2 bu/a./in.	9.4 bu/a./in.
Sunflower	22 in.	5.4 in.	218 lb/a./in.	150 lb/a./in.
Winter wheat	24 in.	10.0 in.	6.0 bu/a./in.	4.6 bu/a./in.

* Long-term (multi-year) slope is less than full slope due to yield reducing factors other than water stress such as hail, freeze damage, insects, diseases, and lodging.

WATER GAIN RELATED to MULCH RATE

Soil water storage (gain) during fallow of a winter wheat-fallow rotation as influenced by straw mulch rate. [Greb. 1979. USDA Bul. 420.]

Location	No. of years tested	Pounds per acre of wheat straw mulch			
		0	2,000	4,000	6,000
		Water gain in inches			
Bushland, TX	3	2.8	3.9	3.9	4.2
Akron, CO	6	5.3	5.9	6.5	7.3
North Platte, NE	7	6.5	7.6	8.5	9.2
Sidney, MT	4	2.1	2.7	3.7	4.0
Average water gain		4.2	5.0	5.7	6.2
Water gain by mulching		—	0.8	1.5	2.0

Wheat straw residue production is about 100 pounds of residue per bushel of grain. That is, wheat residue (lb/a.) = 100 lb (times) bu grain/a.

CROP RESIDUE and EVAPORATION LOSS

Effect of position of winter wheat stubble on water evaporation from soil during fallow of a wheat-fallow rotation on a Weld silt loam near Akron, CO. Data collected during 5 wk of Aug.-Sept. that followed a rain of 2/3 in. [Smika. 1983. SSSAJ 47:988-991.]

Straw position	Evaporation loss (in./day)	Evaporation loss (in.)
Bare soil (residue mowed and hand raked)	0.026	0.91
Flat straw (residue cut at soil surface and spread)	0.022	0.77
1/2 flat - 1/2 standing (distribution obtained by combine harvesting)	0.017	0.59

Standing residue was 18 in. tall, residue amount was 4,100 lb/a., and drill rows were 12 in. apart.

Are there short-term impacts of residue removal?

Study assessed the impact during 1 year following the removal of corn stover (residue) from three Ohio soils under no-till management (8, 15, and 35 years in no-till). [Blanco-Canqui et al. 2006. SSSAJ. 70:266-278.]

Finding: "Soils with reduced stover cover exhibited visible aggregate breakdown/detachment, surface sealing, and crusting in the surface 1.25-inch depth due to the disruptive forces of raindrops."

Conclusion: "In this short-term test, stover removal resulted in increased soil crust strength and reduced soil water content."

Crusts modify soil surface conditions by:

a. Restricting seedling emergence
b. Reducing water infiltration and aeration
c. Increasing surface runoff

RESIDUE: Maximize the use of crop residues

1. Spread residue as evenly as possible at harvest
2. Harvest crop so stubble is as tall as practical
3. Maintain stubble in a standing position
4. Maintain as much residue for as long as possible

TILLAGE and UPPER-PROFILE SOIL WATER LOSS

Effect of different tillage implements on residue reduction and soil water loss in 1 and 4 days after tillage of a Rago silt loam near Akron, CO. [Good and Smika. 1978. J. Soil Water Conserv., p. 89-90.]

Tillage Implement	Residue reduction in one operation	Water loss from the 0 to 5 inch layer after:	
		1 day	4 days
	(%)	(in.)	(in.)
Tandem disk	75	——	——
One-way disk	50	0.33	0.51
Chisel	10	0.29	0.48
Sweep plow	10	0.10	0.14
Rod weeder	15	0.04	0.22

Evaporation losses influenced by:

a. Depth of disturbance
b. Extent of disturbance
c. Crop residue remaining
d. Soil water amount at tillage
e. Weather conditions after tillage

TILLAGE: Minimize the use of tillage

1. Tillage promotes a short-term evaporation spike from the disturbed soil
2. Tillage reduces the amount of crop residues on the soil surface – and that will lead to:
   a. Increased evaporation losses from subsequent water additions and
   b. Decreased water infiltration rates

Additional stored water in soil profile with no-till compared with conventional-till at planting of:+

[Stone and Schlegel. 2006. Agron. J. 98:1359-1366]

Years	Location	Wheat in WW	Wheat in WF	Wheat in WSF	Sorghum in WSF	Reference
		---- inches ----				
1963-66	North Platte, NE		3.4	1.5		Smika & Wicks, 1968
1975-87	Akron, CO		1.7			Smika, 1990
1993-01	Akron, CO		2.8			Nielson et al., 2002
1987-90	Garden City, KS	0.7	1.5	1.5	1.6	Norwood, 1992
1984-93	Bushland, TX	1.1	0.6		0.9	Jones & Popham, 1997

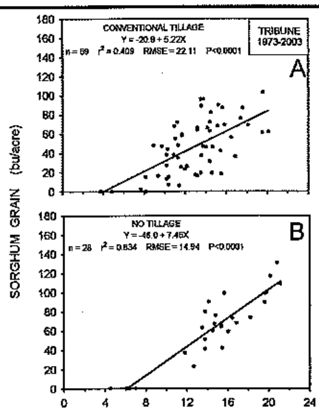
+ WW = continuous wheat, WF = wheat-fallow, and WSF = wheat-sorghum-fallow

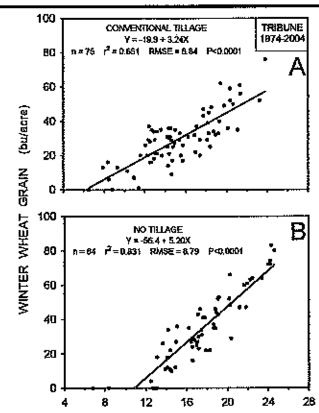
EFFICIENCY of WATER SUPPLY USE during GROWING SEASONS

Efficiency is increased by:

Increased amounts of crop residue acting to:

1. Decrease evaporation through residue's
   a. Blocking solar radiation energy
   b. Maintaining cooler surface temperatures
   c. Decreasing wind velocities at the soil surface.
2. Improve (maintain) infiltration through residue's
   a. Providing temporary water impoundments
   b. Decreasing the likelihood of crust formation because of better aggregation and the cushioning of raindrop impact.





TILLAGE PANS: Fracture tillage pans or soil compacted from traffic (by)

1. Chisel or subsoil only when soil is dry to depth – for better fracturing of soil
2. Chisel or subsoil only as deep as necessary – about 1.5 to 2 inches below problem layer
3. Maintain a relatively slow tractor speed – under 4 mph
   a. Minimizes large clod displacement on the surface and the need for secondary heavy tillage
   b. Minimizes drying caused by excessive soil disturbance
   c. Minimizes residue loss through burying caused by soil mixing

TIMING of IRRIGATION: Use of selective timing of limited irrigation

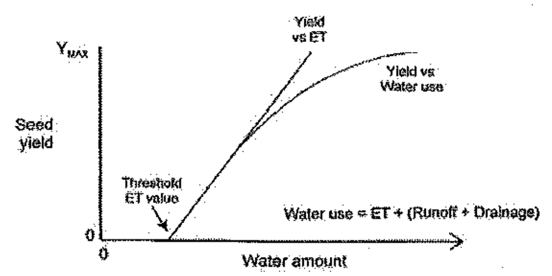
- The importance of timing of irrigation increases as precipitation and water for irrigation decrease

YIELD RESPONSE to WATER (stress factors)

Weighting factors for the relative yield susceptibility to ET deficit during growth periods – for comparisons within a crop.

Crop	Growth period: Vegetative	Flowering	Yield formation	Ripening
Corn	0.14	0.53	0.19	0.14
Soybean	0.10	0.40	0.50	----
Grain sorghum	0.21	0.42	0.21	0.16
Sunflower	0.25	0.42	0.27	0.06
Winter wheat	0.19	0.51	0.25	0.05

CROP YIELD vs. WATER RELATIONSHIPS (patterns)



YIELD RESPONSE to WATER (limited irrigation)

Timing of limited irrigation for maximum seed yield benefit.

Crop	Initiation of limited irrigation....	To avoid (lessen) water stress particularly during
Corn	Near (prior) or at tasseling	Silking
Soybean	Mid to late pod set	Early to mid bean fill
Grain sorghum	Head extension	Flowering
Sunflower	Head development	Disk flowering
Winter wheat	Head extension	Flowering

PREPLANT IRRIGATION: Statements on efficiency of water storage with preplant irrigation.

The most efficient use of irrigation water is made when water is applied as close as possible to the time of plant need. [Stone et al. 1980. Proc. Irrig. Workshop, 7-20. KSU, Manhattan]

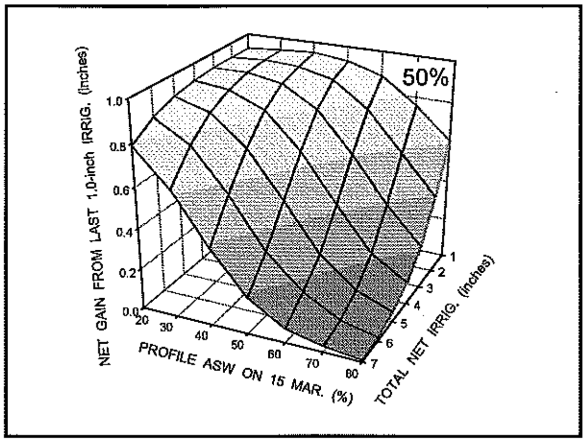
Irrigation use efficiency is greater with in-season than with preplant applications. [Stone et al. 1987. Agron. J. 79:632-636; Musick and Lamm. 1990. Trans. ASAE 33:1834-1842]

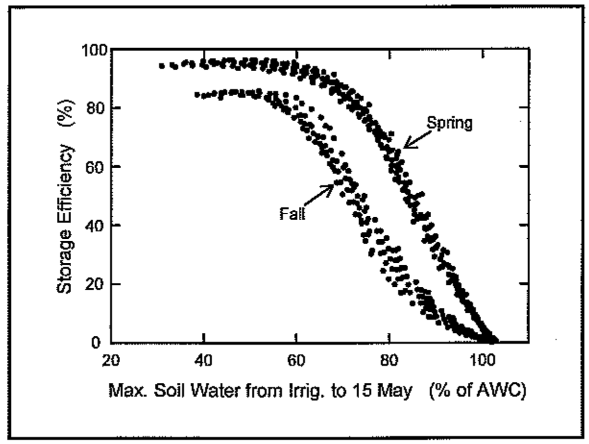
Benefits of preplant irrigation are lowest when soil profiles are moderately wet at time of irrigation. [Musick and Lamm. 1990. Trans. ASAE 33:1834-1842]

Attempting to store water above 63% of available water capacity is highly inefficient. [Wiese and Army. 1960. Agron. J. 52:612-613]

There is little benefit from preseason irrigation if soil water is above 50% of available water capacity. [Hobbs and Krogman. 1971. Can. J. Soil Sci. 51:13-18]

Preplant irrigation that raises soil water above 50% of available water capacity has a high probability of being lost or wasted. [Rogers and Lamm. 1994. Appl. Eng. Agric. 10:37-40]


50%
NET GAIN FROM LAST 1.0-inch IRRIG. (inches)
PROFILE ASW ON 15 MAR. (%)
TOTAL NET IRRIG. (inches)


Storage Efficiency (%)
Spring
Fall
Max. Soil Water from Irrig. to 15 May (% of AWC)

Soil Quality Change in No-Till

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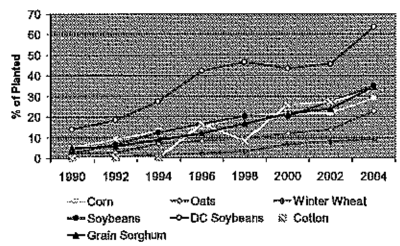
Outline

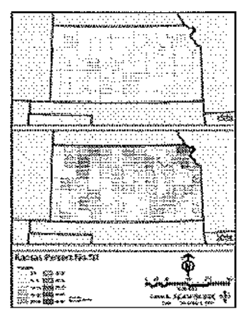
- KS and US cropping systems data
  - Current use and management practices
- Soil quality and management
  - Definitions
  - Parameters
  - Focus of this talk: Physical properties
    - Results from tillage, rotation experiments in KS
- Discussion: What soil management questions still need to be answered?

Kansas No-Till Crops

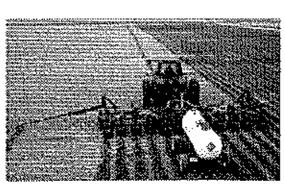


Statewide: 41% conventional, 25% reduced, 20% no-till (CTIC, 2004)

% No-Till all Crops



Soil Quality/Soil Management



What does "Soil Quality" mean?

- Definition: How well it does what we want it to do
- Every person defines it their own way for their own use
- Quality depends on how we use and manage it

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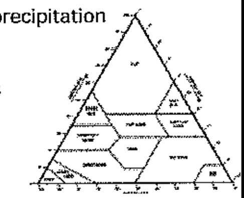
Soil management affects…

- Organic matter
- Soil tilth
- Crop productivity
- CEC, pH
- Erosion potential
- Infiltration
- Compaction
- Available water/short-term drought tolerance
- Wildlife habitat
- Biodiversity
- Air quality
- Water quality
  - Many of these are being discussed at this conference by others

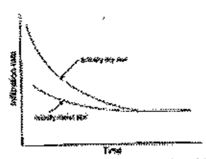
Focus of this talk and my research is on how no-till affects physical properties and processes—because that's what interests me

Infiltration principles

- **Infiltration: Entry of water into soil**
- **Units: in/hour or cm/hour**
- Factors that affect the infiltration characteristics of soil
  - Time from the onset of precipitation
  - Initial water content
  - Soil texture
  - Soil structural properties
    - Aggregate stability
    - Organic matter
  - Surface properties
    - Macropores
    - Crusts or layers

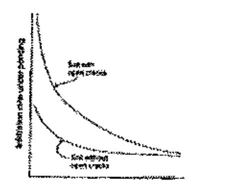


Infiltration and initial water content



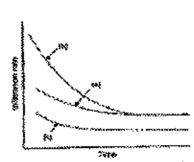
Graphs from Hillel (1998), Environmental Soil Physics

Infitration and macropores



Graphs from Hillel (1998), Environmental Soil Physics

Infiltration and crusts



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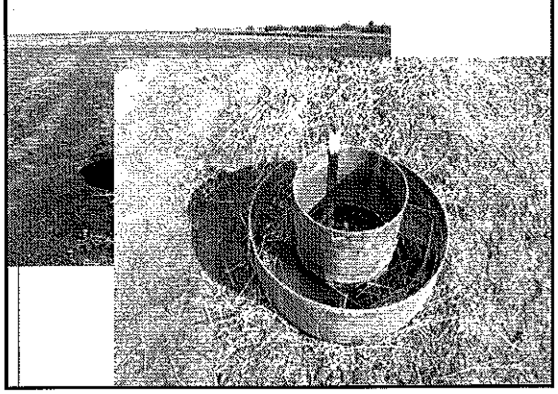
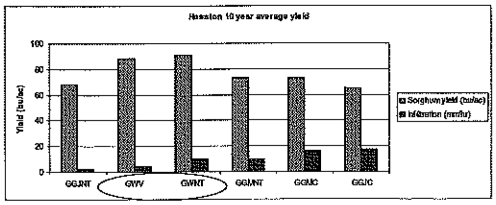
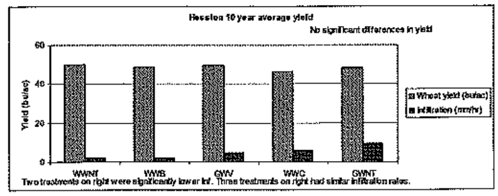


Sorghum yield and infiltration



Highest yields for rotation, not the highest infiltration (2 practices have statistically same infiltration rates.

Wheat yield and infiltration



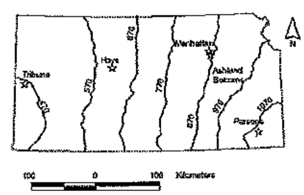
Similar yields for all tillage practices. Different infiltration rates.

Infiltration pitfalls

- Hesston measurements: Taken at one point in growing season (late fall 2007)
- Suspect lateral movement of water below the measured zone (esp. chisel trts.)
- Back to the drawing board next year—to get at what's really happening with better techniques
  - Multiple measurements
    - Depth
    - Temporally and spatially
- Regardless, if we had done any runoff measurements, no-till would have been lower in sediment due to better aggregate stability

Recent KSU Soil Management research

- 5 long-term tillage studies
  - Avg. 23 years
- Effects of tillage on physical properties of soils
  - McVay et al. 2006



Physical properties

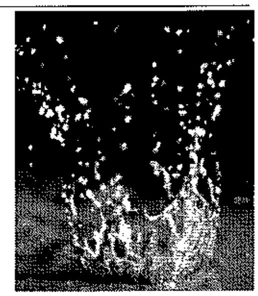
- 0 to 2 inches was the only zone where there were differences in:
  - Organic C: Higher with less tillage
  - Bulk Density: Higher with less tillage
  - Water Holding Capacity: No differences at all
  - Aggregate stability: Better for less tillage

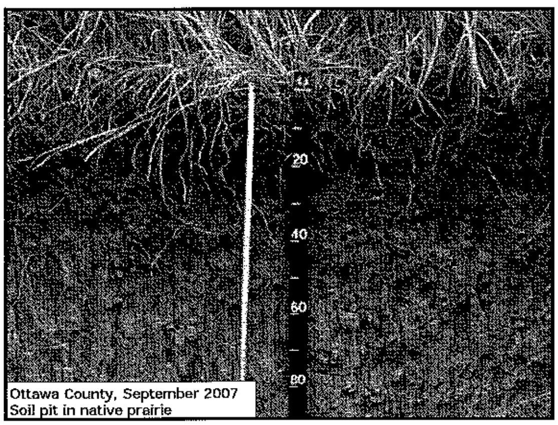
Why worry about residue?

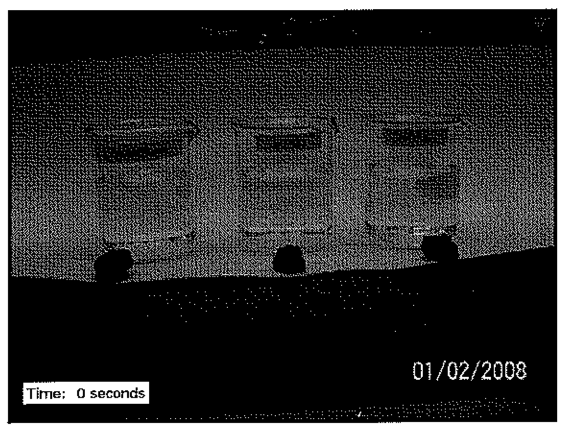
Residue builds soil carbon

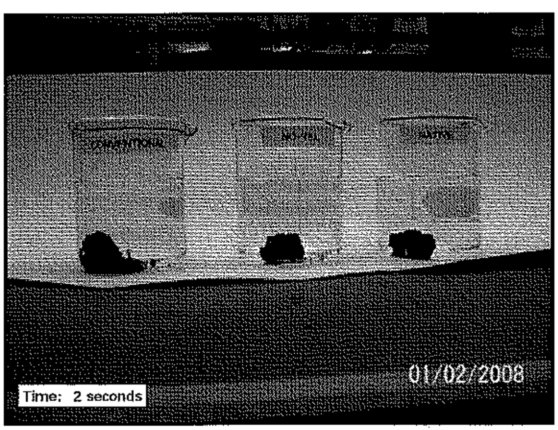
Protection from soil erosion

- Residue:
  Provides physical protection from raindrop impact
- Soil organic matter:
  Binds soil particles, builds structure and stable aggregates

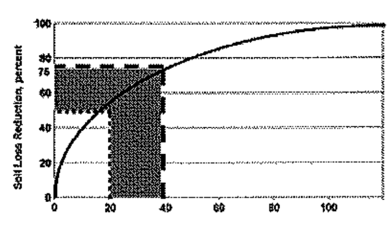






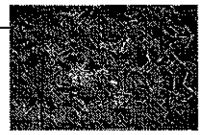


Erosion and residue



40% residue = 75% reduction in soil loss
Water erosion: Need at least 30% residue on field
Roughly 2000 lbs of residue

Estimating residue



20% wheat

- Harvest index:
  - For every 1 pound of grain, 1 pound of residue for corn and sorghum (HI = 1)
- 100 bushel corn crop

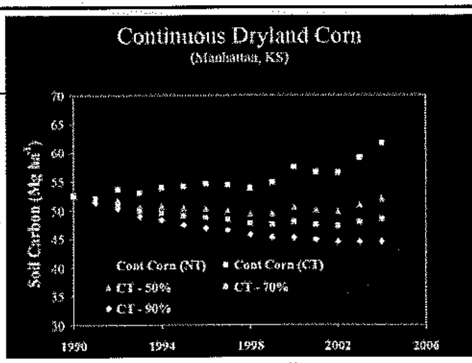
100 bu grain/acre * 56 lbs grain/bu grain * 1 lb residue/1 lb grain

- Equals: 5600 lbs of residue per acre
- Is that enough? How much should we have on the surface at planting time?

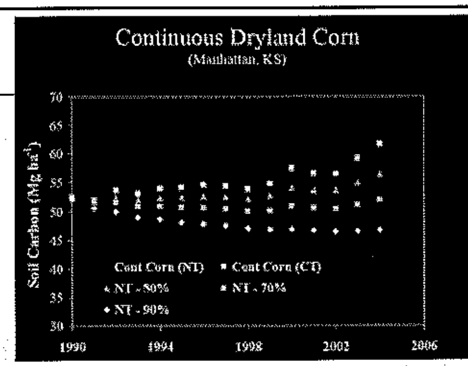
Residue needs—What are we trying to do?

- To maintain soil C?
- To prevent water erosion?
- To prevent wind erosion?
- To conserve soil moisture?
- Do we have any extra to harvest for livestock or (someday) cellulosic ethanol?

- Have to determine the needs on a field by field basis
  - Water erosion: Need 1 ton of residue
  - Wind erosion: Need 1 ton of standing wheat residue, takes more if residue is flat, chopped, or larger diameter
  - To maintain or build soil C? That is a tough one.



Courtesy of Scott Staggenborg, KSU Agronomy



Courtesy of Scott Staggenborg, KSU Agronomy

Tillage operations and residue

Implement	% of residue cover remaining after one pass
moldboard plow	10 - 20
chisel plow	50 - 70
sweeps	80
blade	90
rod weeder	85 - 90
tandem disc	60
springtooth harrow	65 - 75
field cultivator	75 - 80

Over winter: Residue decreases by 10 - 20%

Summary

- No-till is the most sustainable cropping system that we have today
  - Yield
  - Soil quality
  - Natural resource protection
- Important to estimate residue amounts for:
  - Protecting soils from erosion
  - Managing soil C levels

"While the farmer holds the title to the land, actually it belongs to all the people because civilization itself rests upon the soil." - *Thomas Jefferson*

Grain Market Outlook

Cover Your Acres Conference
Oberlin, Kansas

January 22-23, 2008

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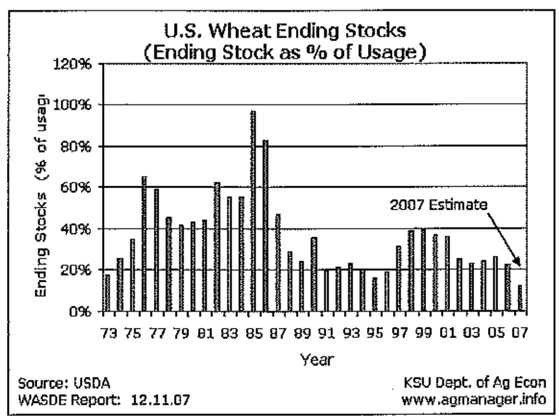
U.S. Wheat Supply-Demand

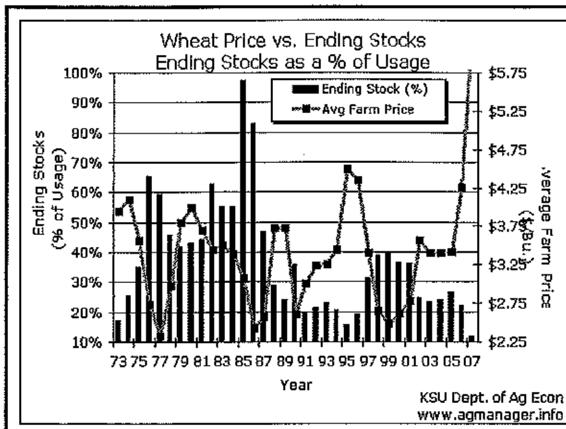
	2005/06	2006/07	2007/08
Planted Ac. (mln.)	57.2	57.3	60.4
Harvested Ac (mln.)	50.1	46.8	51.0
Yield (bu./ac.)	42.0	38.7	40.5
Beg. Stocks	540	571	456
Production	2,105	1,812	2,067
Total Supplies	**2,727**	**2,505**	**2,613**
Food	914	933	945
Seed	78	81	88
Exports	1,009	909	1,175
Feed & Residual	154	125	125
Total Use	**2,155**	**2,049**	**2,333**
End Stocks *(%S/U)*	*(26%)* 571	*(22%)* 456	*(12%)* 280
U.S. Ave. Farm $	***$3.42***	***$4.26***	***$6.20-$6.60***

Production of Major Wheat Exporters

Million Metric Tons

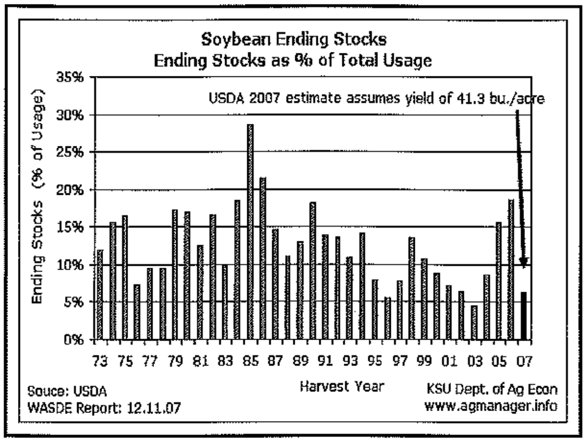
	2006/07	2007/08
□ EU-27	124.80	120.50
□ United States	49.32	56.25
□ Canada	25.27	20.05
□ Australia	9.90	13.00 (12.7)
□ Argentina	15.20	15.00
World Production	593.07	602.31
World Ending Stocks	125.08	110.06





U.S. Soybean Supply-Demand

	2005/06	2006/07	2007/08
Planted Ac. (mln.)	72.0	75.5	63.7
Harvested Ac (mln.)	71.3	74.6	62.8
Yield (bu./ac.)	43.0	42.7	41.3
Beg. Stocks	256	449	573
Production	3,063	3,188	2,594
Total Supplies	**3,322**	**3,647**	**3,173**
Crushings	1,739	1,806	1,830
Exports	940	1,118	995
Seed	93	78	86
Residual	101	71	77
Total Use	**2,873**	**3,074**	**2,988**
End Stocks *(%S/U)*	*(16%)* 449	*(19%)* 573	*(6%)* 185
U.S. Ave. Farm $	***$5.66***	***$6.43***	***$9.25-$10.25***

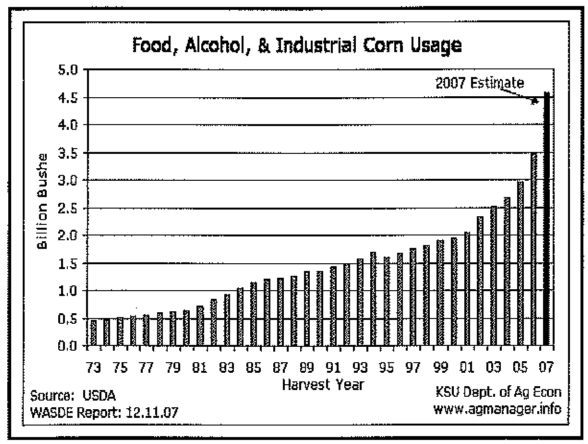


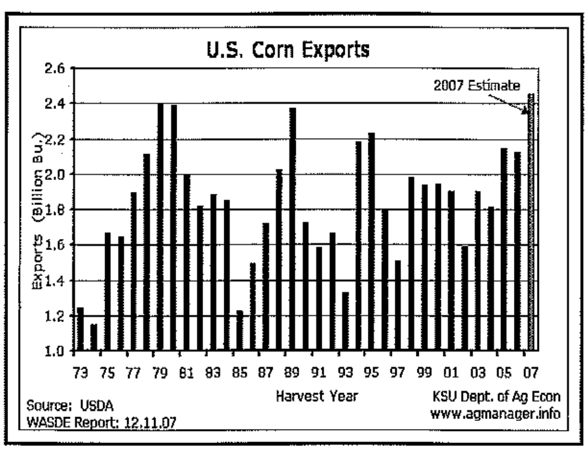
U.S. Corn Supply-Demand

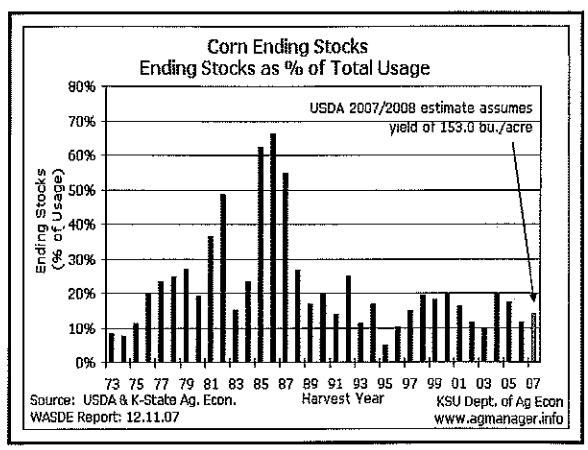
	2005/06	2006/07	2007/08
Planted Ac. (mln.)	81.8	78.3	93.6
Harvested Ac (mln.)	75.1	70.6	86.1
Yield (bu./ac.)	148.0	149.1	153.0
Beg. Stocks	2,114	1,967	1,304
Production	11,114	10,535	13,168
Total Supplies	**13,237**	**12,514**	**14,487**
Ethanol	1,603	2,117	3,200
other Food, Seed, Indust.	1,378	1,371	1,390
Exports	2,134	2,125	2,450
Feed & Residual	6,155	5,598	5,650
Total Use	**11,270**	**11,210**	**12,690**
End Stocks *(%S/U)*	*(17%)* 1,967	*(12%)* 1,304	*(14%)* 1,797
U.S. Ave. Farm $	***$2.00***	***$3.04***	***$3.35-$3.95***

U.S. Grain Sorghum Supply-Demand

	2005/06	2006/07	2007/08
Planted Ac. (mln.)	6.5	6.5	7.7
Harvested Ac (mln.)	5.7	4.9	6.7
Yield (bu./ac.)	68.5	56.2	76.8
Beg. Stocks	57	66	32
Production	393	278	515
Total Supplies	**450**	**343**	**547**
Food, Seed, Indust.	50	45	35
Exports	194	157	275
Feed & Residual	140	109	180
Total Use	**384**	**311**	**490**
End Stocks *(%S/U)*	*(17%)* 66	*(10%)* 32	*(12%)* 57
U.S. Ave. Farm $	***$1.86***	***$3.29***	***$3.20-$3.80***







Dynamics of U.S. Corn Usage

	USDA/WASDE 2006/07	USDA/WASDE 2007/08 est.
Feed and Residual	5,598	5,650[1] (+1%)
Food, Seed, and Industrial	1,371	1,390[2] (+1%)
Ethanol for Fuel	2,117	3,200 (+51%)
Net Exports	2,125	2,450 (+15%)
Ending Stocks	1,304	1,797 (+38%)
Total Usage	12,515	14,487 (+16%)
Production	10,535	13,168 (+25%)

[1] Assumes DDGS retain 30% of the feed value of corn and are included in the feed and residual category by the USDA.

[2] Industrial, food, and seed less ethanol.

Land in Crops

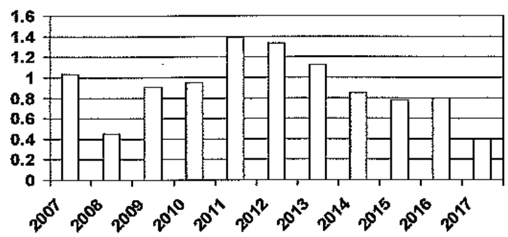
(Millions of acres)

	5 yr. Ave.	07/08USDA	Proj. 08/09
Corn	79.6	93.6	88.0 (-6%)
Soybeans	74.2	63.7	70.0 (+10%)
Hay	62.4	61.8	61.8 (--)
Wheat	59.5	60.4	62.2 (+3%)
Cotton	14.1	10.9	10.0 (-8%)
Grain Sorghum	8.1	7.7	7.4 (-4%)
Principle Crops	297.9	298.1	299.4
CRP		35.9	34.9 (-3%)

Total crop land in the United States – 441.6 million acres

Crop Acres Coming Out of CRP **2007–2017, Millions of Acres**

Source: USDA, FSA



Grain Marketing Considerations

- **Wheat** – Global shortage of quality milling wheat, reduced Australian and Argentinean production, and acres planted N. Hemisphere.
- **Corn/G.S.** – Strong demand from overseas buyers, ethanol demand, and bid for acres.
- **Soybeans** – Dryness hurting Argentinean and Brazilian crops, hectares in Brazil up only 1%, and critically low carryover in the U.S.

Factors to Watch:

- Tight global S/D balances for wheat and soybeans
- Battle for acres this spring
- Harvest of Southern Hemisphere crops

WATER SAVINGS FROM CROP RESIDUE MANAGEMENT

Norman L. Klocke, Water Resources Engineer
Randall S. Currie, Weed Scientist
Troy J. Dumler, Extension Economist
Kansas State University, SWREC, Garden City, KS

Corn growers who irrigate in the Great Plains face restrictions in water, either from lower well capacities or from water allocations, and/or rising energy costs. They need water management practices to maximize grain production. Water savings, even a few inches, can convert water into yield increases. Research has shown that each additional acre-inch of water captured or saved in the root zone potentially can be used for crop transpiration and produce 12-14 bushels of corn.

Evapotranspiration is a two part process. Crop transpiration, water consumed principally by evaporation near leaf and stem surfaces, correlates directly to grain production. Non-productive soil water evaporation has little utility. Soil water evaporation rates are controlled by two factors. When the soil surface is wet, atmospheric energy that reaches the ground drives evaporation rates (energy limited phase). As the surface dries, evaporation rates are limited by the movement of water through the soil to the surface. In sprinkler irrigation during the growing season, most of the evaporation results from the energy limited process because of frequent soil wetting. Crop residues on the surface reduce energy limited evaporation by shading the soil and reducing energy which reaches the soil.

Quantifying soil water evaporation in sprinkler management is the goal of this project. Past projects have demonstrated that reducing soil water evaporation under irrigated corn canopies is possible with flat wheat stubbles on the soil surface. Irrigators need to know the value other crop residues such as, corn stalks and standing wheat stubble, have for reducing evaporation. They need concrete measurements of the soil water evaporation rates in corn canopies with crop residue and irrigation frequencies.

OBJECTIVES

1. Determine the water savings value of various crop residues in irrigated corn.
2. Measure soil water evaporation beneath crop canopy of fully and limited irrigated corn.
    a. From bare soil.
    b. From soil covered with no-till corn residue.
    c. From soil covered with standing wheat residue.
3. Calculate the contribution of evaporation to evapotranspiration.
4. Predict potential economic savings from reducing evaporation with residues.

METHODS

Soil water evaporation was measured during the summers of 2004, 2005, and 2006 at Kansas State University's Research and Extension Center near Garden City, Kansas. Mini-lysimeters were used for the primary evaporation measurement tool. They contained undisturbed soil cores 12 inches in diameter and 5.5 inches deep. The soil cores were extracted by pressing PVC tubing into the soil with a custom designed steel bit. The PVC tubing became the sidewalls for the mini-lysimeters. The bottom of the cores were sealed with galvanized discs and caulking. Therefore, water could only escape from the soil by surface evaporation, which could be derived from daily weight changes of the mini-lysimeters. Weighing precision produced evaporation measurements with a resolution of $\pm$ 0.001 in/day.

Volumetric soil water content was measured bi-weekly in the field plots to a depth of 8 ft in 1 ft increments with neutron attenuation techniques. The change in soil water, form the start to the end of the sampling period, plus measurements of rainfall and net irrigation were the components of a water balance to estimate crop evapotranspiration (ETc).

Measurements of crop residue were adapted from line transect techniques. A coarse screen was laid over a mini-lysimeter. Observations of the presence or absence of residue were recorded for each intersection of screen material. The fraction of the presence of residue and total observations was converted into a percentage of coverage.

Two mini-lysimeters with the same surface cover treatment were placed in a diagonal pattern between adjacent 30-inch rows under the crop canopy. Four replications of bare, corn stover, or wheat stubble surface treatments were placed in high and low frequency irrigation treatments. High frequency irrigation was managed to meet atmospheric demand for full crop evapotranspiration (ETc). The low frequency irrigation treatment received approximately half this amount in half the irrigation events.

RESULTS

Wheat stubble and corn stover, sampled from the actual mini-lysimeters, ranged from 4.3 to 9.8 tons/acre and 92 to 98% of surface coverage (table 1). The 2004 and 2005 wheat crops were especially short in stature due to less fall growth. This led to less stubble mass and coverage of the mini-lysimeters during the following year

Table 1. Crop residue mass and percentage cover at the end of the growing season for mini-lysimeters in soybean and corn field plots during 2004-2006 near Garden City, Kansas.

Crop Residue Cover	Dry Matter tons/ac	Residue Coverage* %
----------------	2004	------------
Bare	0.0	0
Corn	7.3	97
Wheat	9.8	98
----------------	2005	------------
Bare	0.0	0
Corn	9.5	100
Wheat	6.3	91
----------------	2006	------------
Bare	0	0
Corn	7.5	100
Wheat	4.3	92

*Percentage of soil surface covered by residue as determined by the modified line transect method.

Two mini-lysimeters were placed between crop rows, oriented north to south. One was adjacent to the east row and the other near the west row. Comparison of evaporation data (not shown) indicated no statistical difference between the two locations.

Annual differences in average soil water evaporation (Avg E), crop evapotranspiration (ETc), reference ET (ETr) and the ratios of Avg E with either ETc or ETr are shown in Table 2. The climatic conditions in 2004 were cooler and wetter than normal which led to superior crop yields, 230 bu/ac of grain with full irrigation. Hail storms during July 2005 and 2006 led to leaf loss and produced yields of 165 bu/ac and 185 bu/ac, respectively, compared with 230 bu/ac in 2004. Avg E was slightly more in 2004 than the other two years which is consistent with more leaf area in 2004. ETc was less in 2004 with less atmospheric demand for water. These two factors combined to the cause increased ratio of Avg E and ETc in 2004, compared with the other two years. The most ETc occurred in 2005 with the least LAI. However, atmospheric demand for water, during 2005 as indicated by ETr may have masked some of the effects of less leaf area. Average wetting events were the combination of high and low frequency irrigation treatments. These wetting events took place during late June until early September. The weather and hail damage influenced irrigation scheduling for high frequency irrigation. Water was applied according to soil water deficit in the crop root zone.

Table 2. Average soil water evaporation (Avg. E) and evaporation as a ratio of crop evapotranspiration (ETc) and reference ET (ETr) for all mini-lysimeter treatments under a corn crop canopy during 2004-2006 in Garden City, KS.

Irrigation Frequency*	Avg. No. Wetting Events	Avg E in/day	ETc in/day	E/ETc	ETr In/day	E/ETr	Peak LAI*
2004	4	0.046a	0.21c	0.25a	0.26	0.18a	4.4
2005	3	0.043b	0.27a	0.16c	0.36	0.12b	3.4
2006	5	0.042b	0.22b	0.21b	0.30	0.14a	3.7
$LSD_{.05}$		0.002	0.01	0.02		0.005	

Means with same letters in the same columns are not significantly different for alpha=.05.

When yearly data were combined average soil water evaporation (Avg E) from the bare surface treatments was significantly different from the two residue covered treatments. Wheat stubble coverage and dry matter were less in than corn stover in 2005 and 2006 than 2004. Over the three yeas these differences led to less evaporation from the corn stover. ETc and ETr data were the same over all mini-lysimeters since the irrigation frequency treatments were combined. E as a ratio of ETc or ETr showed that covers could reduce E by 50% compared with bare soil.

Although E measurements are presented in daily averages, differences among treatments seem small. If a daily average of 0.03 inch were extrapolated over a 110 day growing season the total difference would be 3.3 inches. Similarly, if a savings of 15% of seasonal ETc (25 inches) is possible, the total would be 3.75 inches. These projections may be somewhat conservative since data collection in this study started approximately five weeks after planting.

Table 3. Average soil water evaporation and evaporation as a ratio of crop evapotranspiration (ETc) and reference ET (ETr) for all bare soil and crop residue covered treatments under a corn crop canopy during 2004-2006 in Garden City, KS.

Surface Cover	Avg E in/day	ETc in/day	E/ETc*	ETr in/day	E/ETr
Bare	0.06a	0.23	0.30a	0.27	0.22a
Corn Stover	0.03c	0.23	0.15c	0.27	0.11c
Wheat Straw	0.04b	0.23	0.16b	0.27	0.12b
$LSD_{.05}$**	0.003		0.02		0.05

Means with same letters in the same columns are not significantly different for alpha=.05.

Comparing soil water evaporation rates from one growth stage to the next can elucidate the influence of crop canopy development. Energy limited evaporation is expected to decrease as crop canopy and ground shading increases. The trend reverses as the crop matures and shading decreases. Concurrently, evaporative demand on the crop increases from planting through mid-season and then decreases through the rest of the growing season.

Results for Avg E and daily ETc followed predictable patterns during the development of corn crop (table 4). Evaporation decreased as the crop developed while ETc increased from vegetative growth to pollination and decreased from pollination to seed fill. The ratio of Avg E to ETc declined during the growing season when the two factors were combined.

Table 4. Soil water evaporation (Avg E) and evaporation as a ratio of crop ET (ETc) and reference ET (ETr) during the growth stages of corn for all mini-lysimeter treatments during the 2004-2006 growing seasons at Garden City, KS.

Growth Stage	Avg Days In Growth Stage	Avg E	ETc	E/ETc	ETr	E/ETr
		in/day	in/day		in/day	in/day
Vegetative	28	0.06a	0.22b	0.27a	0.35	0.17a
Pollination	18	0.05b	0.27a	0.20b	0.33	0.15b
Seed Fill	30	0.03c	0.20c	0.15c	0.25	0.12c
$LSD_{.05}$		0.002	0.02	0.02		0.05

Means with same letters in the same columns for the same year are not significantly different for alpha = 0.05.

More frequent irrigations led to slightly more soil water evaporation and ETc (table 5). The small differences were probably because on average there were two more wetting events in the high versus low frequency treatments. More ETc from the high frequency treatment led to slightly less ratio of Avg E and ETc.

Table 5. Soil water evaporation (Avg E) and evaporation as a ratio of crop ET (ETc) and reference ET (ETr) for low and high frequency irrigation for all mini-lysimeter treatments in during the 2004-2006 growing seasons.

Irrigation Frequency	Wetting Events	Avg E in/day	ETc in/day	E/ETc	ETr in/day	E/ETr	Peak LAI*
Low	3	0.043b	0.21b	0.21a	0.30	0.14b	3.3
High	5	0.044a	0.25a	0.20b	0.30	0.15a	4.4
$LSD_{.05}$		0.0013	0.009	0.02		0.004	

*LAI is leaf area index (leaf top surface area/ground area)
Means with same letters in the same columns are not significantly different.

Significance of Results

Crop residues, completely covering the soil, reduced soil water evaporation by 14% of crop evapotranspiration (ETc). Average growing season ETc for corn in the central Plains is 24 to 26, which translates into 3.4 to 3.6 inches of water savings. These water savings could disappear if half of the surface cover were removed with one pass of a tandem disk.

The water savings from crop residues have two impacts on profitability. First, irrigation pumping costs for typical wells in the central Plains have risen to $7 to $10 per acre-inch, which means the savings in operating costs from residue management could be $25 to $35 per acre. Second, irrigators with limited water supplies cannot meet full ET demand and crop yields are reduced from full potential. In this case, water savings from crop residues could be utilized for increasing crop yields. With good crop management, an inch of water of water could be translated into 12 bushels per acre of corn. For corn prices from $2.50 to $3.50 per bushel, the impact of 3 inches of extra water from crop residue management with full surface coverage could be $100 to $150 per acre.

Additional growing and non-growing season benefits from crop residues include infiltration enhancement, runoff reduction, soil erosion reduction, water quality enhancement, fertilizer savings, and precipitation entrapment. Dryland research has indicated that off-season water conservation benefits from crop residues are worth 2 to 4 inches annually in the central plains states. These benefits augment the growing season advantages of crop residues.

Acknowledgements:

Partial funding for this research was furnished by: the Ogallala Initiative, the US Department of Interior, and the US Department of Agriculture.

No-till Wheat 101

Brian Olson and Dale Leikam
K-State

Topics

- Varieties and tillage
- County Comparisons – No-till (NT) versus Conventional-till (CT) Wheat
- Seeding Rate
- Management Decisions

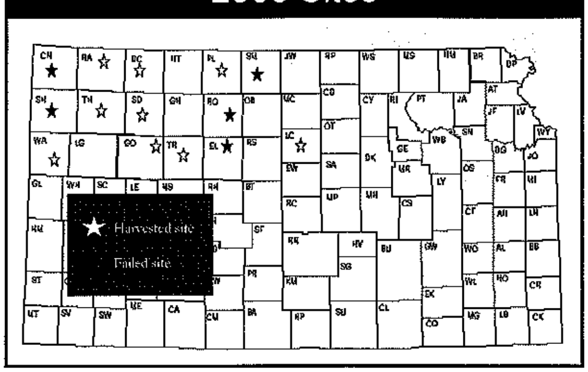
Objective

- Background
  - More no-till production on the High Plains
  - Producers would like to move their operation to all no-till
- Can no-till wheat production work across a wide range of environments?
- Are there differences in how wheat varieties respond to different tillage systems?

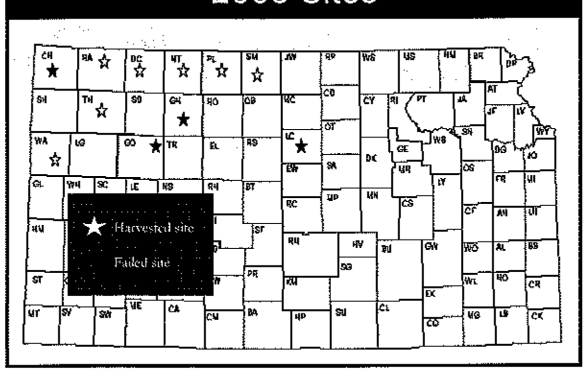
Methods

- No-till versus conventional-till on area producers fields
- Try to find plots where the field has been in no-till for at least the last two years when the row crops have been growing or longer. (transition period)
- In May, fields are located for fall planting
  - Systems are maintained throughout the summer
- Plots are planted by K-State faculty
- Varieties
  - Jagger, 2137, Stanton, Jagalene, Cutter, T-81
- Seeding Rate – 85 lbs/A
- Yield is taken at harvest
- Project duration
  - 2004 – multiple crop failures due dry weather and a late freeze
  - 2005 and 2006 – variable growing conditions across the area

2005 Sites



2006 Sites



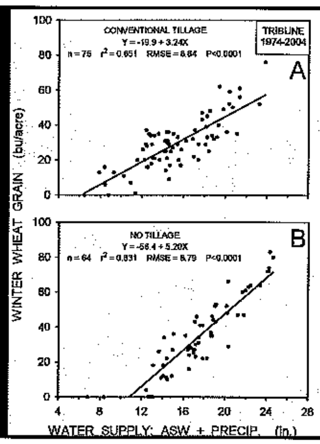
Cover Your Acres Winter Conference. 2008. Vol. 5. Oberlin, KS

Varieties and Tillage

- No tillage by variety interaction
- The yield of a variety maybe higher or lower between tillage systems, but its yield in comparison to the other varieties was similar across tillage systems.

NT and CT yields

	Yield Potential	
Tillage	Below 35	Above 35
	-----------bu/A-----------	
No-till	17.5	55.7
Conventional-till	23.6	54.3
LSD (0.1)	4.1	



Conclusion

- No tillage by variety interaction
- Environment affected tillage system
  - High yielding - tillage systems similar
  - Low yielding – conventional-till yielded more

Management Decisions

- Nitrogen
- NITROGEN
- NITROGEN!
- Time
- Seeding Rate
- Variety – no differences
- No-till Drill
- Copper and Zinc

Nitrogen Deficiency Symptoms

- Pale green - yellow coloration. Starts at leaf tip & down midrib.
- Slow, stunted plant and root development
- Mobile - lower leaves first
- Reduced tillering
- Low Protein

D. Leikam, K-State

No-Till Wheat and Nitrogen

- What happened ?

D. Leikam, K-State

Nitrogen Application Rate

- Time/Method Of Application Is At Least As Important As Application Rate
- Nitrogen Requirements Are Related To *Yield Potential* - Evaluate Yield Goals On a Field By Field Basis

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Setting A Yield Goal

Set For Individual Fields - Realistic, Yet Progressive

High Enough To Take Advantage Of Favorable Years - But - Not So High As To Jeopardize Profits/Stewardship

Appropriate Yield Goals Falls Between Highest Yield Ever Obtained In A Field And 5 Year Average

D. Leikam, K-State

Preplant Profile N Test

- This is a preplant test - not an in-crop test
- Typically 2 or 3 foot depth
- Not reliable after fertilizer applied or in growing crop
- Less reliable on sands

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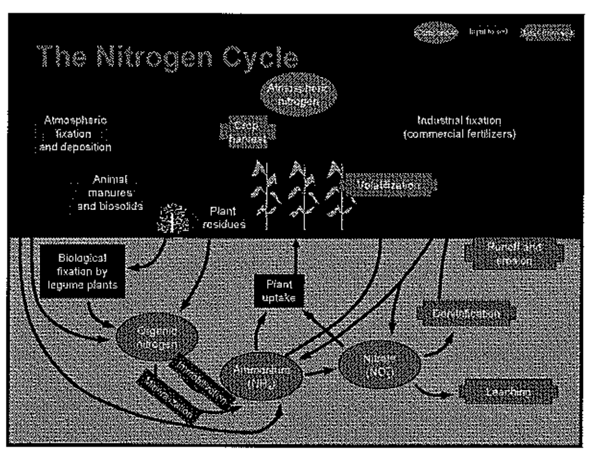
N Management in Conservation Tillage Systems

- **Mineralization (less microbe activity)**
- **Immobilization (residue)**
- **Volatilization (residue, enzyme, moist soils)**

D. Leikam, K-State



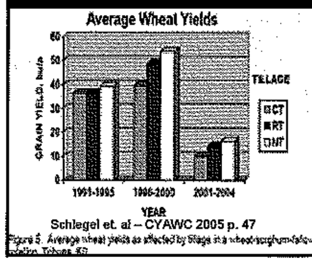
Fertilizer Management

- Best practices
  - Place nitrogen below residue before or at planting
  - Apply at least ½ to all required nitrogen to the field before or at planting
  - Apply phosphorus (20 to 30 lbs/A) with the seed to stimulate root development
  - Do not place UAN or anhydrous ammonia with the seed
  - Apply additional nitrogen in the spring with or without herbicide

D. Leikam, K-State

Time

- Transition period into no-till
- The first four years ground will likely be hard and difficult to work with



Schlegel et. al – CYAWC 2005 p. 47

- In the fifth to sixth year, ground will start to become more mellow.
- Don't pull the field cultivator out there no matter how hard and dry the surface becomes

Seeding Rate

- In no-till, there is more of a chance to have a poor stand
  - Crop residue inhibiting good seed soil contact
  - Soil surface is hard on new no-till fields
  - Older equipment may not provide enough down pressure
  - Speed – going to fast with disc openers may cause shallow seed placement
  - Higher seeding rate used – seed is cheap – ensures adequate stand

Wheat Seeding Rates

- Jagalene planted at all sites in 2005 and 2006.

Lbs/A	Bu/A
85	50.2
102	50.2
120	49.4
68	48.5
LSD (0.05)	NS

- No seeding rate by tillage interaction

No-till Drill

- More down pressure needed with disc openers
  - More steel, more weight, heavier drills
  - Disc openers cut the soil while hoe drills dig into the soil
  - Damp residue can cause problems
- Hoe drills can be used for no-till but can easily become clogged with residue
  - Need high clearance
  - Wide rows

Factors Affecting Copper

- Copper availability is reduced by complexation with organic matter.
  - Occurs in high organic matter, poorly-drained mineral soils
  - High moisture content and low aeration reduces Cu availability and limits root growth
- Soil compaction which limits root growth may induce Cu deficiency
- High soil pH, phosphorus and zinc increase Cu deficiency
- Camberato, J. J., et al. 2003. Copper Deficiency in Wheat. Clemson University Cooperative Extension Service

Factors Affecting Zinc

- Highly calcareous soils with high pH
  - These soils are most likely deficient in iron
- Soils with high phosphorus levels
- Cool soil temperatures
- Low organic matter, coarse textured soils
- Compacted soils
- Peat or muck soils that have high O.M.
- Ganoe, K et al. 2007. Zinc. Cornell University Cooperative Extension, Fact Sheet 32

Copper and Zinc studies

- Five locations
  - Four locations in Thomas county
  - One location by Hutchinson (abandoned)
- Soil test taken at each location
- 1 lb/A of either copper or zinc was applied prior to jointing

Site Information

	Thomas 1	Thomas 2	Thomas 3	Thomas 4
Variety	Danby	Jagalene	Wesley	Jagalene
Copper (ppm)	1	1	1	0.7
Zinc (ppm)	1.3	1	0.7	0.8
O.M.	3.1	1.8	2.2	2.2
pH	6.4	6.8	6.8	7.6

Results

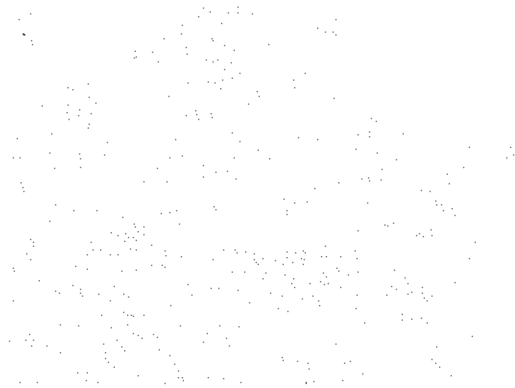
	Thomas 1	Thomas 2	Thomas 3	Thomas 4	Average
	---Bu/A---				
Copper	37.7	58.9	75.0	87.2	64.7
Zinc	35.6	58.5	73.1	85.5	63.4
Untreated	32.8	60.8	74.0	85.7	63.2
LSD (0.05)					NS

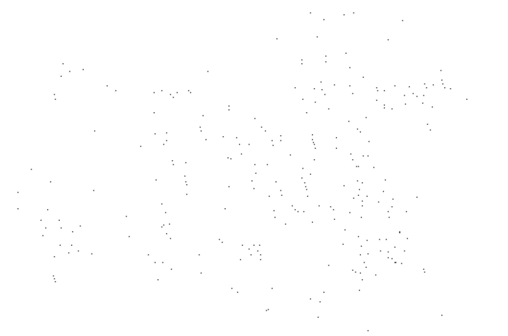
Summary

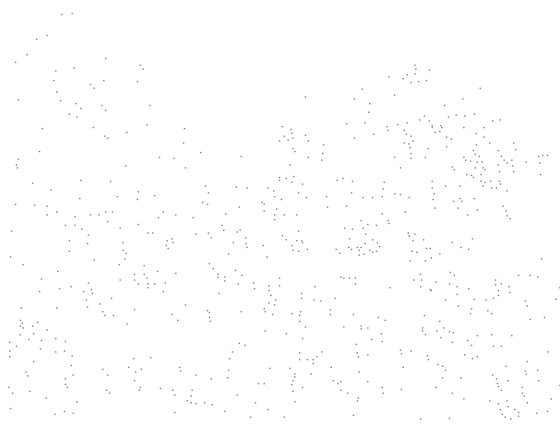
- Benefits of no-till will take 4 to 6 years
- Variety makes no difference
  - Diseases – tan spot
- Manage your nitrogen
  - Can significantly reduce yields if not managed properly
- Higher seeding rates can ensure an adequate stand
- No-till drills
  - down-pressure and speed influence seeding depth
- Copper and Zinc
  - Preliminary research indicates no benefit

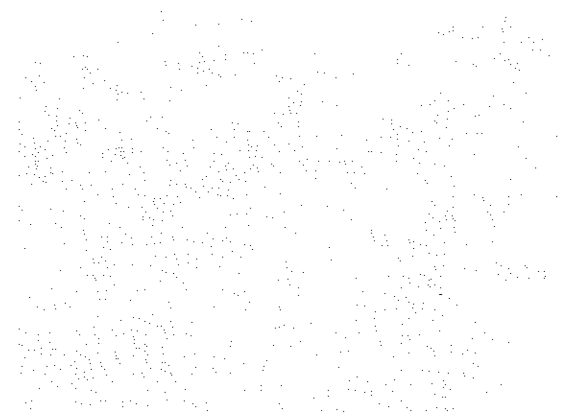
New Corn Seed Traits for No-till

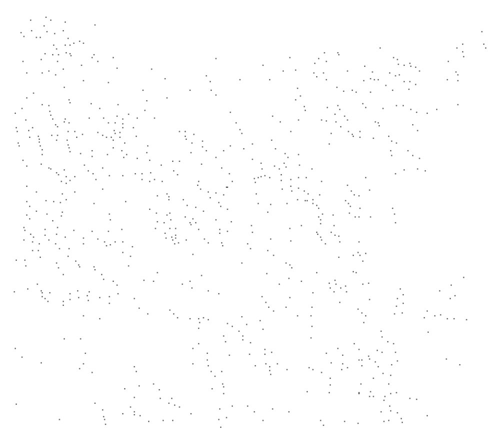
Rich Peters, Channel-Bio











Farmer Panel: Crop Rotations
Northwest Kansas Crop Residue Alliance

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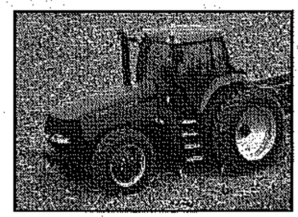
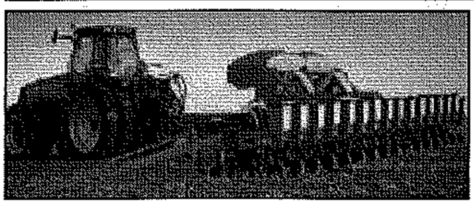
- **STX 4WD 275 hp—500 hp.**





- **Case IH**
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No-Till Planters & Drills for depth control in planting, and a uniform stand

- **DMI**
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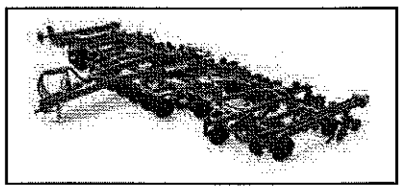

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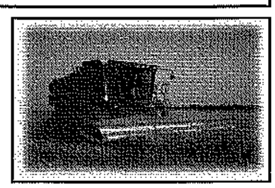

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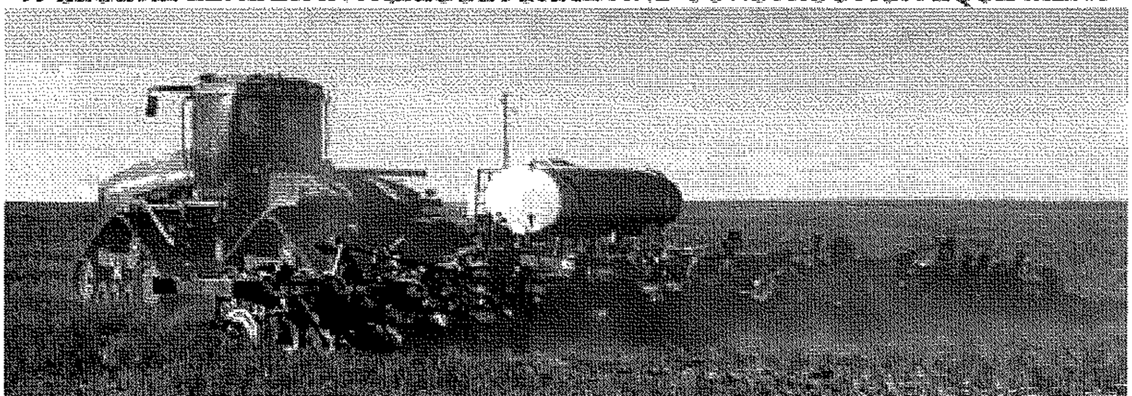

nutri-till'r 5310

Benefits:

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