Cover Your Acres Winter Conference

4th Annual
January 23 and 24, 2007
Gateway, 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 Weed Control Options for Grain Sorghum*	Chloride, Sulfur, and Slow-release Urea in Crops	Auto-guidance: Does it pay?	All New Sprayer Technologies	Sunflower Management	Sponsor Displays
9:40 - 10:28	2007 Farm Bill	Managing Crops with Limited Irrigation	Starter Fertilizer in No-till	The State of Fertilizer in 2007	Quality Forage and Using GRP/GRIP for Silage	
10:35 - 11:23	Starter Fertilizer in No-till	Getting the Most out of Glyphosate*	Crop Yields and Costs in No-till	Kansas Corn: Keeping Tools in the Toolbox	Avoiding Strip-till Mistakes	
11:30 - 12:30	Flexible Fallow	New Weed Control Options for Grain Sorghum*		Noon Meal		
12:40 - 1:40	Auto-guidance: Does it pay?	Government Programs and No-till				
1:50 - 2:38	Crop Yields and Costs in No-till	Ogallala Aquifer: Where are we going?	Dryland Soybean Production (farmer)	Corn Trait Management	What Precision Ag Can Do for You	Sponsor Displays
2:45 - 3:33	Government Programs for No-till	Q and A on snow and ice on wheat	Flexible Fallow	New DuPont Herbicides for RR Corn	Benefits of Ammonium Chloride	
3:40 - 4:28	Getting the Most out of Glyphosate*	Yields and Economics of No-till Wheat	Chloride, Sulfur, and Controlled-release Urea in Crops	Global Technologies	Sunflower Management	
4:35 - 5:23	Sprayer Ownership: Is it for you? (farmer)	Skip-Row Corn	2007 Farm Bill	Economics of Biofuels	Q and A: No-till Drills, Sprayers and AMS	
5:30 – 7:30	Industry Sponsored Bull Session (refreshments and heavy hors d'oeuvres provided) in commercial display area **will only be held on Tuesday, January 23.**					

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 Stan Miller at 785-693-4561

PLEASE TURN ALL CELL PHONES OFF OR TO VIBRATE. THANK YOU

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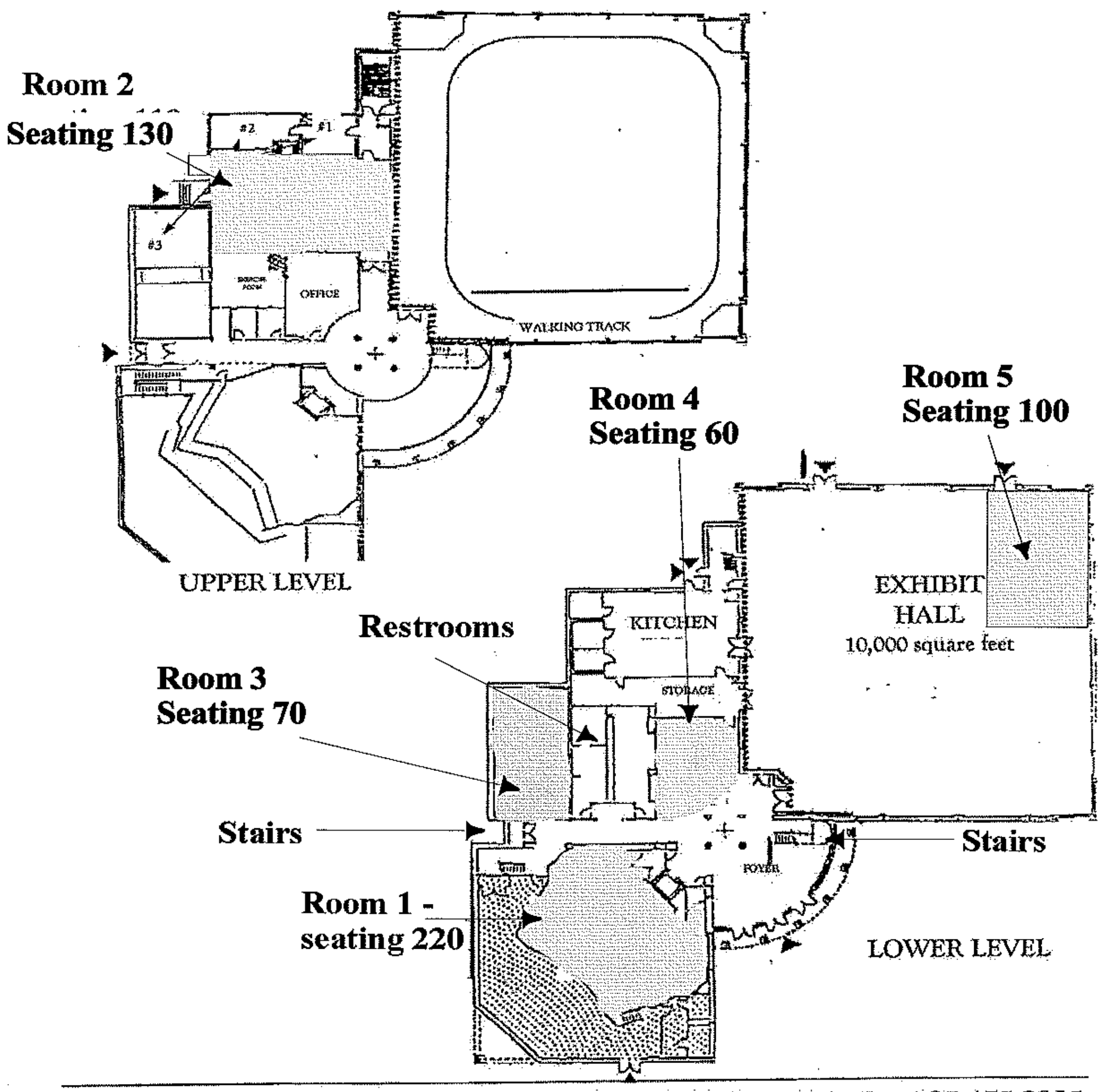
Industry Sessions	**Company Presenter**
All New Sprayer Technologies	Hoxie Implement
The State of Fertilizer in 2007	Cargill AgHorizons
Kansas Corn: Keeping Tools in the Toolbox	Kansas Corn Commission
Corn Trait Management	Garst
New Dupont Herbicides for Roundup Ready Corn	DuPont
Global Technologies	Lang Diesel
Economics of Biofuels	Pioneer Seed
Sunflower Management	National Sunflower Association
Quality Forage and Using GRP/GRIP for Silage	National Sorghum Producers
Avoiding Strip-till Mistakes	Hoxie Implement
What Precision Ag Can Do for You	Cargill AgHorizons
Benefits of Ammonium Chloride	Evans Enterprises
Question and Answer session: No-till Drills, Sprayers, and AMS	Southwest Implement

GATEWAY

Oberlin, Kansas

The Premiere Exhibition, Meeting & Conference Center
for the Tri-State Area



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

Weed Control in Grain Sorghum, New and Old

Dave Regehr
K-State Agronomy
dregehr@ksu.edu
Mobile: 785-532-9216

EPA Approved Section 18 Emergency Exemption in KS in 2006

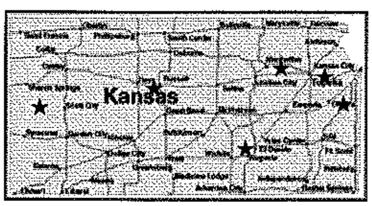
- Objective: Allow use of soil-applied *Lumax* in grain sorghum
- Emergency: to control triazine- and ALS-resistant pigweed *(Amaranthus)* species
- *Lumax* contains *Dual Magnum,* atrazine, and *Callisto*

Section 18 Emergency Exemption Process

- Requested by KS Sec. of Agric. Supported by grower organizations, Syngenta, K-State R&E
- Documenting the biological emergency
  - What triggered it?
  - Could it not have been foreseen?
  - Percent of crop likely to be affected?
  - Percent yield losses over a range of infestation levels?
  - Why current control methods not adequate?
- Documenting the economic emergency
  - Verifiable yield or quality loss estimates with next best alternative

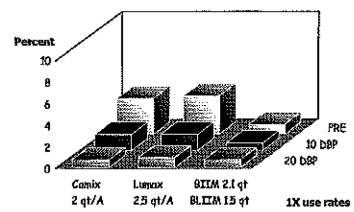
K-State Locations for Testing Sorghum Tolerance of *Lumax* and *Camix*

2003-2005



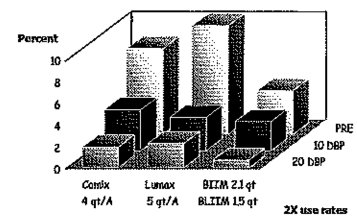
Grain Sorghum Injury, 1X Use Rates

15 site-years in Kansas



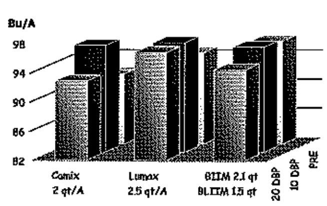
Grain Sorghum Injury, 2X Use Rates

15 site-years in Kansas



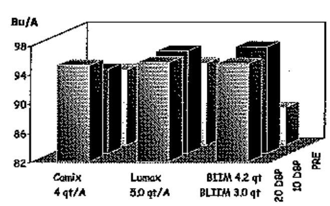
Grain Sorghum Yield, 1X Use Rates

15 site-years in Kansas



Grain Sorghum Yield, 2X Use Rates

15 site-years in Kansas



2006 Emergency Exemption Provisions

- Rate: 2.5 qt/acre
- Timing: 7 to 14 days preplant
- No use on coarse-textured soils; no soil incorporation
- Only on *Concep*-treated grain sorghum seed
- Allowed tank mixtures for burndown, e.g. atrazine, glyphosate, paraquat, 2,4-D
- Indemnified label: risk (of crop injury or failure to control) rests with end user

2.5 qt *Lumax* contains

- 1.67 lb *s*-metolachlor (1.75 pt *Dual II Magnum*
- 0.63 lb atrazine (0.63 qt *AAtrex 4L*)
- 0.168 lb mesotrione (5.36 fl oz *Callisto*)

- 2.1 qt *Bicep II Magnum* contains
  - 1.26 lb *s*-metolachlor
  - 1.63 lb atrazine

2006 Field Experiments in KS

- Compare soil-applied *Lumax* with labeled soil- and foliar-applied treatments for control of Palmer amaranth and other broadleaf weeds, as appropriate to study site

Sedgwick County Expt: Clearwater

- Clearwater Coop
  - Blanket silt loam, no-till
  - Highly variable pigweed pressure
  - Sorghum planted 22 May; ground dry and hard
  - PRE (NOT LPP) on 24 May; POST on 18 June
  - Precip: 0.9" at 13 Days After Planting; 0.4" at 19 DAP; 1.9" at 22-26 DAP
  - Yield: dry weight of sorghum heads clipped on 24 August

Palmer Amaranth Control in Grain Sorghum Clearwater, KS, 2006 (Regehr & Cramer)

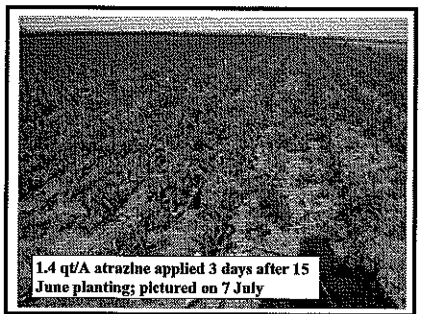
	Rate	-% Control (DAT)-			HWgt
PRE tmts		27	39	87	Lb/A
Lumax	2.5 qt	95	94	93	4591
Bicep Magnum	1.67 qt	31	33	46	3180
Dual Magnum	1 pt	8	5	44	2942
Atrazine	1.4 qt	6	13	24	1972
Untreated Check	-	-	-	-	2176
Weed-Free Chk	-	-	-	-	4224
LSD (0.05)		21	21	23	2005

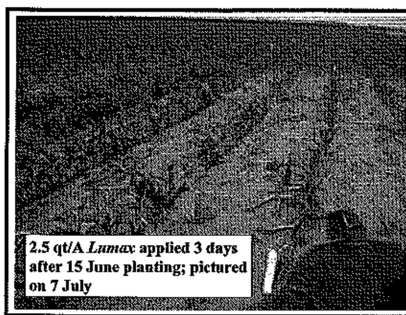
Palmer Amaranth Control in Grain Sorghum Clearwater, KS, 2006 (Regehr & Cramer)

	Rate	% Control (DAT)			HWgt
PRE/POST tmts		27	39	87	Lb/A
Dual Magnum	1 pt	8	5	44	2942
DM/Buctril	/1 pt	8	13	34	2856
DM/Peak+coc	/0.75 oz	6	26	39	2820
DM/Clarity	/8 fl oz	18	50	56	1856
DM/Aim+nis	/0.5 fl oz	0	14	29	2131
DM/2,4-D amine	/1 pt	9	36	43	2546
Untreated check		-	-	-	2176
Weed-free Check		-	-	-	4224
LSD (0.05)		21	21	23	2005

Sedgwick County Expt: Colwich

- Gruenbacher Farm
  - Blanket silt loam, tilled; corner of center-pivot field
  - Extremely high Palmer pigweed pressure; >250 plants/ft²
  - Planted 15 June into disked ground
  - PRE (NOT LPP) on 18 June; POST on 7 July
  - Precip: 1.0" at 1 DAP; 0.5" at 4 DAP; 1.6" at 7 DAP
  - Yield: sorghum plants clipped on 24 August, dried, weighed


1.4 qt/A atrazine applied 3 days after 15 June planting; pictured on 7 July


2.5 qt/A *Lumax* applied 3 days after 15 June planting; pictured on 7 July

Palmer Amaranth Control in Grain Sorghum Colwich, KS, 2006 (Regehr & Cramer)

	Rate	-% Control (DAT)-			D Wgt
PRE tmts		21	35	63	Lb/A
Lumax	2.5 qt	91	65	59	3376
Bicep Magnum	1.67 qt	70	41	15	2002
Dual Magnum	1 pt	51	13	13	731
Atrazine	1.4 qt	13	3	3	648
Untreated Check	-	-	-	-	384
Weed-Free Chk	-	-	-	-	5128
LSD (0.05)		15	21	16	1083

Palmer Amaranth Control in Grain Sorghum Colwich, KS, 2006 (Regehr & Cramer)

	Rate	-% Control (DAT)-			D Wgt
PRE/POST		21	35	63	Lb/A
Dual Magnum	1 pt	51	13	13	731
DM/Buctril	/1 pt	54	19	11	1321
DM/Peak+coc	/0.75 oz	45	20	14	1104
DM/Clarity	/8 fl oz	36	48	36	2939
DM/Aim+nis	/0.5 fl oz	58	34	16	2037
DM/2,4-D amine	/1 pt	45	48	33	2680
Untreated check		-	-	-	384
Weed-free check		-	-	-	5128
LSD $_{(0.05)}$		15	21	16	1083

Stevens County Expt, 2006

- Clay loam soil previously planted to wheat. Strip-till seed bed preparation January 2006.
- Kochia burndown with 0.75 lb ae glyphosate on June 1; Pioneer 85Y34 planted on May 31 at 28000 s/a, EPP = May 18, PRE = June 1, and POST on July 8. EPP and PRE @ 20 gpa, POST @ 10 gpa spray solutions.
- Weeds: KOCZ = *Kochia scoparia*; Ruth = Russian thistle; Paam = Palmer amaranth; Puvi = puncturevine
- Yield: grain harvested 24 October

Stevens County Expt, 2006

- Slight drought stress at the time of burndown led to inadequate control of established kochia; significant pressure from kochia regrowth
- Atrazine PRE with POST *Peak* controlled Palmer amaranth 90% suggesting that most of the population was not ALS or triazine resistant

Broadleaf Weed Control in Grain Sorghum Stevens Co, KS, 2006 (Thompson & Roberts)

	Rate	—% Control 7/21—			-7/7-	Yield
PREPLANT		KOCZ	Ruth	Paam	Puvi	Bu/A
Lumax	2.5 qt	71	94	87	94	22
Bicep Lite M	1.3 qt	94	99	88	94	56
Dual Mag	1 pt	80	88	81	96	47
PRE						
Lumax	2.5 qt	75	96	91	98	31
Bicep Lite M	1.3 qt	83	95	93	95	41
Dual Mag	1 pt	78	91	88	94	30
LSD $_{(0.05)}$		12	5	9	9	28

Broadleaf Weed Control in Grain Sorghum Stevens Co, KS, 2006 (Thompson & Roberts)

	Rate	—% Control 7/21—			-7/7-	Yield
PRE		KOCZ	Ruth	Paam	Puvi	Bu/A
Lumax	2.5 qt	75	96	91	98	31
Lumax	2 qt	78	94	87	95	33
PRE/POST						
Atra/*Peak*+nis	1qt/0.5oz	92	98	89	95	42
DM/Peak+nis	1pt/0.5oz	87	95	85	94	45
Untreated	-	-	-	-	-	11
Weed-free	-	-	-	-	-	60
LSD $_{(0.05)}$		12	5	9	9	28

KSU Agric Research Center - Hays, 2006

- No-till field with 2005 wheat stubble; maintained weed-free
- Preplant on 18 May; planted and PRE on 30 May; POST on 19 June
- Precipitation adequate for activation: 0.5" during 22-31 May; 1.7" during 11-17 June; then very dry until mid-August
- Low weed pressure: Prsp = prostrate spurge; Tupw = tumble pigweed; Puvi = puncturevine
- Yield: grain harvested 10 November

Broadleaf Weed Control in Grain Sorghum KSU Ag Res Cntr, Hays, 2006 (Stahlman & Geier)

	Rate	—% Control 9/6—			Yield
PREPLANT		Prsp	Tupw	Puvi	Bu/A
Lumax	2.5 qt	99	95	100	23
Bicep Lite M	1.5 qt	91	91	90	20
PRE					
Lumax	2.5 qt	100	100	100	24
Bicep Lite M	1.5 qt	100	99	93	19
Lumax	2 qt	100	100	98	19
Untreated		-	-	-	20
LSD $_{(0.05)}$		6	6	7	6

Broadleaf Weed Control in Grain Sorghum KSU Ag Res Cntr, Hays, 2006 (Stahlman & Geier)

	Rate	—% Control 9/6—			Yield
PRE/POST		Prsp	Tupw	Puvi	Bu/A
Bicep Lite M /*Starane*+atraz	1.5 qt /0.67pt+1pt	100	100	100	22
POST					
Marksman	1 qt	88	89	95	23
Starane+atra+coc	0.67pt+1.5pt	100	100	100	23
Aim+atra+coc	0.75floz+1.5pt	100	100	93	25
Aim+2,4-D+nis	0.75floz+1pt	90	75	98	21
Untreated		-	-	-	20
LSD $_{(0.05)}$		6	6	7	6

Pigweed Control with *Lumax* in 2006

- Control generally, but not always, satisfactory
- Requires adequate rainfall for activation
- Possibly more control difficulties with later-season uses:
  - Pigweed more vigorous at warmer temperature?
  - Activation moisture less dependable?
- Needs context of an integrated approach to weed management
  - Crop rotation
  - Good control in wheat stubble ahead of sorghum

Lumax for Grain Sorghum in 2007?

- Renewal application from KS Dept of Agric; encouragement from producers welcome
- Syngenta decide on label
  - Indemnification language?
  - Split applications encouraged: 1.5 qt LPP followed by 1 qt PRE, or 1.25 qt LPP fb 1.25 qt PRE
- K-State will support application with new control data

2006 – Another Round of K-State Tests on *Lumax* Tolerance by Sorghum

- Five on-station sites: Tribune, Hays, Hesston, Manhattan, Ottawa
- Two application timings:
  - 10-14 day preplant vs. Preemerge
- No surprises
- Sorghum injury at Hesston and Ottawa due to timing, rates, and rainfall

Lumax at Hesston Field, 2006 (Mark Claassen, K-State Agronomist)

- LPP on June 3; planted and PRE on June 16
- 3.5 inches rain, mostly 1st few days after planting
- Considerable sorghum injury from 2X (5 qt/A) rate of *Lumax* PRE
  - 50% stunt early; 4-5" stunt at 40 days
  - 10% stand loss
  - Delayed flowering
  - Significant yield loss
- Less severe injury, no yield loss, from 2X *Lumax* LPP

Lumax at Ottawa Field, 2006 (Larry Maddux, K-State Agronomist)

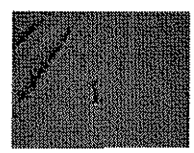
- LPP on May 13; planted and PRE on May 24
- 2.5 inches rain in 1st week after planting
- Significant sorghum injury from 2X (5 qt/A) rate of *Lumax* PRE
  - Seedlings w/bleaching: 70% @ 1 wk; 15% @ 2 wk
  - Stunting: 40% @ 2 wk; 25% @ 4 wk
  - Delayed flowering
  - Yield loss: yes at 90%; no at 95% confidence levels
- Less severe from 2X *Lumax* LPP

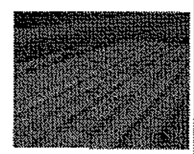
Potential for Use on Coarse-Textured Soils?

- Syngenta grain sorghum trial conducted near Osceola, Nebraska
- Sandy loam soil with a CEC = 6; pH = 6.8
- *Lumax* applied PRE at 2.5 qt/acre
- Irrigated after application and prior to sorghum emergence

Worst Case Scenario Trial on Sandy Soil

- Very severe grain sorghum injury observed with *Lumax*, *Bicep II Magnum* and *Bicep Lite II Magnum*
- Neither *Bicep* product labeled for sorghum on sandy soils





Follow the label

Postemerge Backup if Soil-Applied Not Satisfactory?

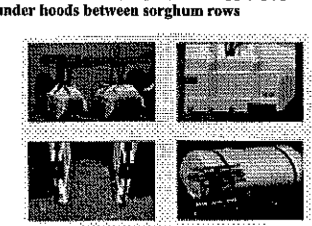
- Early-POST herbicides with contact activity; kill via foliar burn
  - Want "established" sorghum; broadleaf weeds less than 2 inches
- Atrazine + crop oil concentrate
- Bromoxynil (*Buctril, Broclean* etc.) + atrazine
- Carfentrazone (*Aim* etc.) + atrazine + NIS

Postemerge Backup if Soil-Applied Not Satisfactory?

- Mid-POST herbicides with systemic activity, on broadleaf weeds 4-8" tall
- *Peak* + atrazine + crop oil conc.
- *Ally* + 2,4-D
- Dicamba + atrazine
- 2,4-D + atrazine
- *Starane* for kochia control
- *Paramount* + atrazine + MSO: some postemerge grass activity; also field bindweed control

Other Options for Selective Control

- Cultivation; Canopy sprayers to apply glyphosate under hoods between sorghum rows



Developing new weed control options for sorghum

Mitch Tuinstra
Director – Center for Sorghum Improvement

Sorghum producer surveys indicate that grassy weed control is a major limitation to sorghum production in the Central Plains. Although herbicides are an important component in grain sorghum weed management, post-emergence management of grassy-weeds continues to be a problem. Many producers currently use pre-plant herbicides such as atrazine and metolachlor, followed by post-emergence herbicides such as atrazine, 2,4-D, and dicamba. However, absence of rainfall to activate these herbicides may decrease their efficacy, and post-emergence herbicides are not always available or may cause crop injury. Furthermore, several important weeds, especially *Amaranthus*, have developed resistance to commercially available herbicides such as atrazine.

The K-State Center for Sorghum Improvement is actively pursuing research to develop new post-emergence weed control options and strategies for use in sorghum production. One project focuses on development and optimization of acetolactate synthase (ALS) inhibiting herbicide technologies for use in sorghum to provide a cost-effective, one-pass, post-emergence weed control program. A sorghum genotype with tolerance to ALS inhibiting herbicides, hereafter referred to as Tailwind, was identified in 2003. Seeds of Tailwind and a herbicide susceptible genotype were evaluated with imidazolinone (IMI) and sulfonylurea (SU) classes of ALS inhibiting herbicides. In each treatment, the Tailwind plants showed essentially no damage after spraying and the conventional sorghum plants were dead indicating that Tailwind had cross-resistance to IMI and sulfonylurea classes of ALS inhibiting herbicides.

Tailwind was crossed with various elite sorghum parent lines. Progenies derived from these crosses were evaluated to determine the number of genes involved in the expression of the tolerance trait. These studies indicated a major, partially-dominant gene with the expression of tolerance being influenced by additional modifier genes. Plant breeding efforts were initiated by backcrossing the tolerance trait into commercially important sorghum pollinator parents including Tx430, Tx2737, Tx2783, 00MN7645, and HP162 as well as important sorghum seed parents including Wheatland, Tx3042, OK11, QL41, and Tx643 with selection for herbicide tolerance in each generation.

Gene sequencing efforts were initiated to determine if a target sight mutation in the ALS gene might explain the herbicide tolerance phenotype. Two amino acid mutations were found in the herbicide resistant genotypes. One of the mutations, a Tryptophane to Leucine conversion in the ALS enzyme, has been associated with expression of IMI and SU herbicide tolerance in numerous crop and weed species.

The Kansas State University Research Foundation (KSURF) currently is working with potential AgChem Industry partners to identify and register new herbicide compounds that can be commercialized to provide improved grassy weed control options in sorghum.

The 2007 Farm Bill

Troy Dumler
Extension Ag Economist
K-State Research and Extension

Cover Your Acres Winter Conference
Oberlin, KS January 23 & 24, 2007

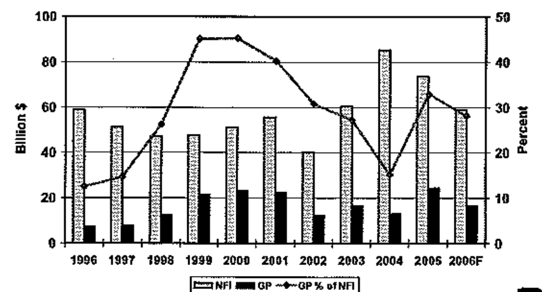
Driving Factors for the 2007 Farm Bill

- Economic Conditions
- The Budget
- Trade
- Political Environment

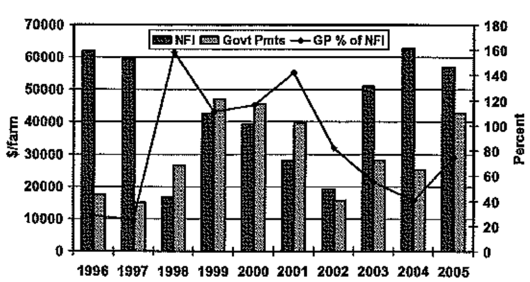
Economic Conditions

- Net farm income is down in 2006
  - Estimated at $58.9 billion
  - Down from record $85.4 and $73.8 billion in 2004 and 2005
  - 10-year average = $57.2 billion
  - Crop income looks good in 2007
- Importance of government payments
  - Averaged 23% of NFI in 1990s
  - Averaged 31% of NFI in 2000s

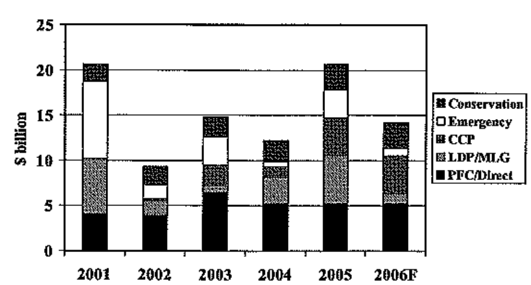
Net Farm Income and Government Payments (1996-2006)



KFMA Net Farm Income



Government Payments by Program

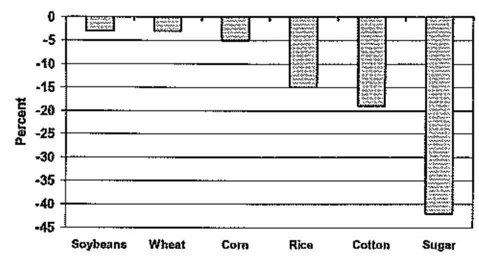


ABARE Study on Elimination of U.S. Farm Subsidies

- Net present value impact of elimination of U.S. subsidies (2007-2020)
  - $120 billion in budget savings
  - $65 billion loss in gross farm income without improved market access
  - $50 billion loss in gross farm income with less ambitious market access improvements
  - $7 billion gain in gross farm income with more ambitious market access improvements

ABARE – Australian Bureau of Agricultural and Resource Economics

Change in US crop gross income with elimination of subsidies (2007-2020)

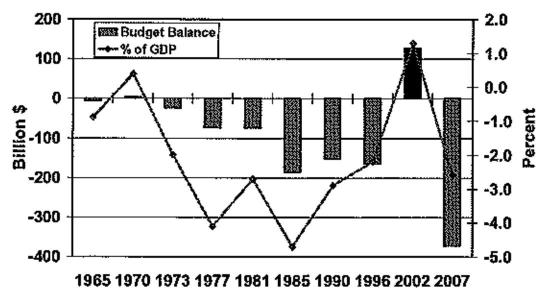


Source: ABARE

Issues with Current Government Programs

- Equity of Farm Income Support
  - One of the most common criticisms of farm subsidies is that "large farms get all the payments"
- Effectiveness of programs in low yield/high price environments
- Farm household income is higher than nonfarm household income

The Budget - Deficits Are Not the Only Factor



The Budget

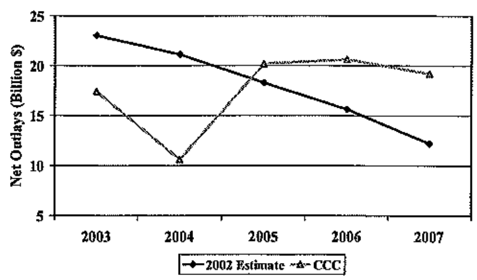
- Budget Baseline
  - 2002 Baseline vs. 2007 Baseline
  - Each year the Congressional Budget Office estimates the cost of current programs 10 years in the future
  - Current forecasts call for higher commodity prices, resulting in lower government payments
  - If the budget baseline is reduced, fights for resources could get interesting

Budget Baseline

- According to Farm Bureau
  - Nutrition funding expected to increase 15%
  - Conservation funding will rise 35%
  - Commodity programs will decrease 42% to $57 billion over six years (half of authorized $ in 2002)

Source: AFBF, Dec. 7, 2006

Commodity Credit Corporation Outlays



Trade

- WTO (Doha Round) Negotiations
  - In July 2004 all members agreed to the following regarding agriculture:
    - Improve market access (reduce tariffs on imports)
    - Eliminate export subsidies
    - Reduce trade-distorting domestic subsidies (farm payments)

Trade

- WTO (Doha Round) Negotiations
  - Hoped to have agreement by December 2005
  - Agreed to complete a blueprint agreement by April 30
  - Vowed to complete the entire round by the end of 2006.
  - Talks suspended in July 2006
  - President's trade-promotion authority (TPA) expires in July 2007
  - 2002 Farm Bill expires in September 2007

Trade

- WTO Litigations
  - Brazil case against US cotton
    - Step 2 program ruled illegal, had to be fixed by July 1, 2005
    - Export credit guarantees for other commodities ruled illegal
    - Determined that direct payments are not Green Box subsidies because restriction on planting fruits and vegetables
  - More litigations likely if agreement not reached

The Political Environment

- Democratic Congress
  - House Ag Committee Chair – Collin Peterson (MN)
  - Senate Ag Committee Chair – Tom Harkin (IA)
- Both like the current farm bill and want to focus more on energy
  - Peterson would also like a permanent disaster program
  - Harkin would like to focus more on conservation

The Political Environment

- More players speaking out on Farm Bill (more negative coverage)
  - Nutrition and food assistance are key to the Farm Bill coalition
    - Some are starting to question why grains are subsidized and "more nutritious" foods are not
  - Anti-poverty groups speaking out against ag subsidies as a cause of global poverty (Oxfam)
  - Conservation groups (EWG, American Farmland Trust)
  - Developing countries
- Ag groups not united

Sources of Government Payments

Crop	Marketing Loans	Counter-Cyclical Pmts	Direct Payments	Total
	------- Percent of Total Support --------			
Corn	33	28	39	100
Soybeans	57	14	29	100
Cotton	11	53	36	100
Rice	23	23	54	100
Wheat	9	25	66	100

Source: Informa Economics

The Political Environment

- More players looking for additional funding
  - Conservation
  - Food safety and homeland security
  - Rural development
  - Energy
  - Fruits and vegetables

Options for the 2007 Farm Bill

- Change little from the 2002 Farm Bill
- Introduce "Income Assurance" programs that guarantee revenue instead of price
- Concentrate on "green" conservation programs
- Focus more on renewable energy
- Include other commodities
- ???

Timeframe for 2007 Farm Bill

- 2006
  - Congressional hearings
  - WTO negotiations stalled
- 2007
  - Organize Congressional committees and staffs
  - Hold additional Congressional hearings
  - Administration recommendations in late Jan. or Feb.
  - Pass final version by Sept. 30, or extend current 2002 Farm Bill one year

Olsen's Agricultural Lab

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Increasing Fertilizer Use Efficiency

Presented to:
Cover Your Acres Winter Conference
Oberlin, KS
January 23 & 24, 2007

Topics

1. Starter Fertilizer
2. Benefits of Soil Testing

Progression of Soil Tillage Systems in the Last 100 Years

- Moldboard Plow
- Conventional
- Minimum Tillage
- Stubble Mulch
- Ridge Till
- Strip Till
- No Till

Development of Fertilizer Placement Systems

- Broadcast
- Knife in anhydrous ammonia
- Starter fertilizers
- Fertigation
- Dual placement
- Dribble band
- Deep placement

Use of Starter Fertilizer

- Definition
- Used in all tillage systems
- Benefits
  - Early growth response caused by cool, wet soil conditions.
  - Low OM soils have limited mineralization potential.
  - Dryland soils have no nutrients from application of irrigation water.
  - Fertilizer rate reduction for P_2O_5 and Zn.
  - Yield response when soil tests are high.

Corn Yield Response to Starter Fertilizer

Dr. Barney Gordon
Department of Agronomy, KSU – Manhattan, KS

Table 1. Effects of N concentration on starter response in irrigated corn

Lb/A N-P_2O_5-K_2O	2-year Avg. bu/A
Control, no starter	169
5-15-5	187
15-15-5	192
30-15-5	210
45-15-5	210
60-15-5	209

Gordon, Kansas State U.

Starter Fertilizer Placement in High Phosphorus Soils

F. Ronald Mulford – University of Maryland

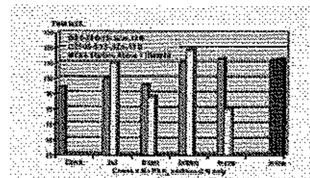
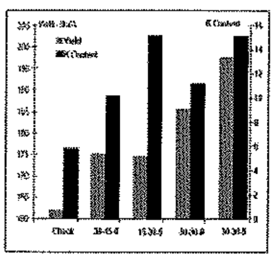


Figure 1. Effect of varying starter N rates and placement methods on corn yields, University of Maryland, 2001.

Corn Yield Response to K in NPK Starter Fertilizer

Dr. Barney Gordon – Department of Agronomy, KSU – Manhattan, KS



Soil conditions:
- pH = 6.2
- OM = 2.4%
- Bray P1 = 40 ppm
- Exch K = 420 ppm

Starter fertilizer combination:
- 28% UAN
- 10-34-0
- KTS (0-0-25-17)

Reduction of Application Rate if Fertilizer is Applied as a 2 x 2 Band

Nutrient	% Reduction
N	0
P_2O_5	25 (dual)
P_2O_5	50 (band)
K_2O	0 – 10
S	0 – 10
Zn	75 – 90

Guidelines for Salt Injury to Corn, Sorghum, & Soybeans from Application of Starter Fertilizer

Placement	Sandy Soils	Non-sandy Soils
	Salt Index	
With Seed	5	5 – 7
¼" to ½" from seed	10	10 – 15
1" to 2" from seed	20	20 – 40
> 2" from seed	20+	40+

Salt index = NH_4-N + K_2O + (1.5 x S) per acre

Note: The amount of starter fertilizer for soybeans is ½ of the above amounts.

Calculation of Salt Index

20 gallons 8-20-5-5-0.5 per acre
228 lbs. product/acre
18 lbs. NH_4-N/acre
11 lbs. K_2O/acre
17 lbs. S/acre (%S x 1.5)
46 lbs./acre = Salt Index

Soil Test Guidelines for Use of Starter Fertilizers for Corn with Yield Goal > 180 bu/a

Soil Test	Starter Fertilizer Only
Bray P1	25 – 50 ppm
Bicarbonate P	18 – 30 ppm
Exch K	200 – 400 ppm
Ca-P Ext. S (OM < 1.5%)	8 – 15 ppm
DTPA Zn	1.0 – 1.2 ppm

Note: A starter only or starter/broadcast application can be used at lower soil test levels.

Fertilizer Application in No Till Systems

- Slightly higher N fertilizer requirement
  - Cooler soil temperature reduces mineralization
  - Volatilization losses in high pH soils
  - Surface placement effects
- Use starter fertilizer
  - Commonly applied in-row
  - Salt toxicity may be a problem
    - <6 gallons/acre 10-34-0
    - <3 gallons/acre 8-20-5-5S-0.5 Zn
    - Do not use for salt sensitive crops, such as dryland soybeans.
- Limited mobility of P_2O_5 fertilizer
  - Recent research indicates limited mobility

Soil Phosphorus Mobility

Dr. John Kovar
National Soil Tilth Laboratory – Ames, IA

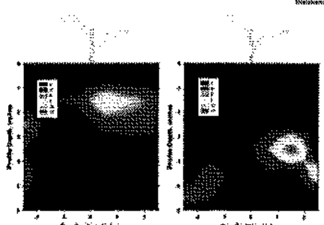


Figure 2. Profile distribution of bio-available P 68 days after dribble application of 15-30-10 (left) and 60-30-10 (right) two inches to side of corn row.

Fertilizer Application in Strip Tillage Systems

- Apply fertilizer 8 – 10" below seed.
  - 100% of N requirement if fall applied.
  - 30 – 50% of N requirement if spring applied.
    - At least 30 days before planting.
    - Fertigate or broadcast remainder of N.
  - No salt damage from phosphate fertilizer.
  - Application of potash in sandy soils?
- Use starter fertilizer using guidelines previously presented.

Soil Testing Opportunities

- Objective of soil testing is to optimize crop yields.
- Experience at Olsen's Lab.
  - Most irrigated soils are tested.
  - Many dryland soils are not tested.
  - Approximately 25% of the surface samples have a subsoil sample tested for nitrate.
    - High subsoil nitrate test = fertilizer cost savings
    - Low subsoil nitrate test = increase crop yields
  - Approximately 20 – 30% of soils tested are grid samples.
    - Be selective in choosing fields.
    - pH, OM, NO_3-N, P, K, Zn – most common

Soil Testing Opportunities (cont.)

Impact of Subsoil Nitrate Test for Corn

Fertilizer Cost Savings

1. Lab fee = $4.25/sample/65 acres
2. Labor to collect sample = $65.00/sample/65 acres
3. Fertilizer savings for 25 lbs N/A @ $0.40/lb N
   - Cost of sample = $1.07/A
   - Fertilizer savings = $10.00/A
   - Net savings = $8.93/A = $8,930/1,000 acres

Soil Testing Opportunities (cont.)

Impact of Subsoil Nitrate Test for Corn

Crop Yield Increase from Soil Test

1. Lab fee = $4.25/sample/65 acres
2. Labor to collect sample = $65.00/sample/65 acres
3. Subsoil nitrate test = 25 lbs additional N/A
4. Yield increase = 25 bu/A @ $3.25/bu
5. Additional fertilizer cost = $10.00/A at $0.40/lb N
6. Additional revenue =
   - ($81.25/A yield - $10.00/A fert. - $1.07/A lab) = $70.18/A
   - ($70.18/A)(1000 A) = $70,180

SUMMARY

1. Use of starter fertilizer in no till and strip till cropping systems often results in economical yield increases.
2. Application of combinations of N P K S Zn fertilizers may be beneficial regardless of soil test values, especially in cold/wet soil conditions and in situations when large amounts of crop residue are present.
3. Do not exceed the N, K_2O, and S guidelines when placing starter fertilizer in direct contact with the seed.
4. The ratio of N to P_2O_5 in starter fertilizer should be 2 to 1 or more.

SUMMARY (cont'd.)

5. P_2O_5 fertilizer may move into the soil profile several inches a few weeks after application when applied with UAN fertilizer in a dribble band application.
6. A subsoil nitrate-N test may result in a significant fertilizer cost savings when the residual nitrate-N test is inherently high.
7. A subsoil nitrate-N test may result in a considerable increase in gross revenue when the residual nitrate-N is lower than expected.
8. Approximately 20 – 25% of the soil samples received by Olsen's Lab are accompanied with subsoil samples.

SUMMARY (cont'd.)

9. The majority of the soil samples received by Olsen's Lab are from irrigated soils. The potential of increased soil testing of dryland soils, along with increasing gross revenue from dryland farming, is high.
10. Fertilizer Recommendation Guidelines
    - Olsen's Lab
      - www.olsenlab.com
      - Click on "Fertilizer Info."
    - Kansas State University
      - www.oznet.ksu.edu/agronomy/soiltesting

FLEXIBLE SUMMER FALLOW IN THE NORTHERN HIGH PLAINS

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Water is frequently the most limiting resource for dryland crop growth in the semiarid areas of the High Plains. Summer fallow is commonly used to stabilize winter wheat production in this region of high environmental variability. Winter wheat-fallow is the predominate cropping system in the High Plains, but water storage efficiency during fallow is frequently less than 25% with conventional tillage. The advent of reduced- and no-till systems have generally enhanced the ability to capture and retain precipitation in the soil during non-crop periods of the cropping cycle, making it more feasible to reduce the frequency of fallow and intensify cropping systems relative to wheat-fallow.

In the High Plains, annual precipitation is concentrated during the warm season from April to September. Hence, inclusion of a summer crop, e.g., corn or grain sorghum, in a 3-yr system of wheat-summer crop-fallow increases the efficient use of precipitation by reducing the frequency of summer fallow and using more water for crop transpiration. In addition to increased precipitation use efficiency and grain yield, more intensified dryland cropping systems increase potentially active surface soil organic C and N, effectively control winter annual grass weeds in winter wheat, and increase net return and reduce financial risk.

Although summer fallow helps to stabilize crop yields, frequent use of summer fallow jeopardizes the long-term sustainability of dryland systems by degrading the soil resource and reducing profitability. A dynamic system involving flexible summer fallow, whereby a grower's decision to transition from a summer crop to winter wheat with a short-duration spring crop or summer fallow is based on several dynamic factors including soil water and economics, might be preferable to a static system incapable of responding to the highly variable climatic and economic scenarios indicative of the region.

Investigating the Elimination of Summer Fallow

A study was initiated in the spring of 1999 to investigate the impact of eliminating summer fallow as the means to transition from a summer crop to winter wheat. Spring-planted crops (oat/pea for forage, spring canola, proso millet, dry bean, and corn) were no-till seeded into sunflower residue at the High Plains Agricultural Laboratory located near Sidney, NE in 1999, 2000, and 2001. A chemical summer fallow treatment was included for comparison purposes. Gravimetric soil water contents were collected to a depth of 4 ft, in 1-ft increments, immediately prior to seeding winter wheat (Table 1). Gross returns were calculated based on five-year average prices for the region, excluding any government payments. Cost of production budgets were developed for each spring-planted crop using common production practices and the University of Nebraska budget generator. These values were used to determine the return to land and management for each observation with an annualized return developed for the two-year spring-planted crop–winter wheat system.

Table 1. Gravimetric soil water content in the surface 4 ft at winter wheat seeding following six spring crop treatments at Sidney, NE.

Preceding spring crop	1999-2000	2000-2001	2001-2002	3-yr mean
	%			
Summer fallow	14.1	14.9	16.0	15.0
Oat/pea forage	10.2	10.2	12.4	11.0
Spring canola	9.1	9.2	12.1	10.2
Proso millet	9.1	8.5	12.2	9.9
Dry bean	9.4	10.4	11.5	10.4
Corn	7.2	9.4	10.2	8.9
LSD (5%)	1.5	1.0	1.2	1.1

Precipitation during the wheat growing season was less than the 30-yr mean in two of the three years of the study. During the grain filling period (June), precipitation was considerably less than normal in all three years of the study. Averaged across all three years, oat/pea for forage and proso millet provided financial returns similar to that of summer fallow. Winter wheat grain yields and returns, averaged across all three years, were greatest after summer fallow, with wheat after oat and pea for forage providing the next greatest yields and returns. Annualized returns to land and management suggests that systems involving oat/pea for forage and proso millet are economically competitive with systems using summer fallow. The system involving dry bean had the largest range in returns and was slightly less competitive than the previous systems over the three years of study. Corn and canola are not economically viable as transition crops in these systems, although regionally adapted canola germplasm could change this.

The cost of summer fallow was $37.22/acre. A combination of returns to the transition crop (fallow replacement crop) + relative wheat returns indicates that systems without summer fallow are feasible (Table 2). System improvement may come from improving transition crop yields or decreasing the negative effects of the transition crop on wheat yields.

This suggests that it may be feasible to eliminate summer fallow in the northern HighPlains. However, the risk of persistent drought is great in this region. A partially fixed, partially flexible cropping system might be of value to balance the benefits of more intense cropping systems with the environmental uncertainties of dryland agriculture in the semiarid High Plains. A winter wheat-summer crop-flexible fallow system, whereby the decision to replace summer fallow with a spring-planted crop is partially based on soil water in the spring and the price relationships of potential crops, might allow growers to continuously crop during periods of above normal precipitation, but fall back to a more conservative rotation using summer fallow during times of below normal precipitation.

Table 2. Annualized net return for the spring crop and subsequent winter wheat crop at Sidney, NE.

Preceding spring crop	1999-2000	2000-2001	2001-2002	3-yr mean
		$/acre		
Summer fallow	-2.56	16.83	-23.44	-3.06
Oat/pea forage	36.88	-9.08	-22.69	1.70
Spring canola	-20.37	-43.13	-51.78	-38.43
Proso millet	2.52	-10.31	-0.61	-2.80
Dry bean	41.16	-51.68	-25.52	-12.01
Corn	-13.83	-46.80	-37.98	-32.87
LSD (5%)	7.06	5.53	5.71	7.85

Evaluating Crops for Use in a Flexible Summer Fallow System

In a previously conducted study, the grain yields of two short duration crops (pinto bean and proso millet) consistently responded positively to increasing soil water at planting (Data not shown). The long-duration crops (corn, grain sorghum, and sunflower) did not consistently respond to increasing soil water at planting with increased grain yield, although there was a significant positive correlation between soil water at planting and dry weight of the crop at 12 wk after planting. The correlation of grain yield to soil water at planting appeared to decrease as the days from planting to harvest increased.

Taken together, these previous studies suggested that short duration crops, particularly short duration crops that are harvested by mid-summer (such as oat/pea for forage), are critical for the success of the winter wheat-summer crop-flexible fallow system. In 2004, a study was initiated to determine the relationship of crop grain or forage yield to plant available soil water at planting. The study was conducted on silt loam soils in 2004 and 2005 at Sidney, NE and Akron, CO. A range of soil water levels was established with supplemental irrigation prior to planting. Four crops (spring triticale for forage, dry pea for grain, proso millet for grain, and foxtail millet for forage) were no-till seeded into corn residue in a split-plot design with four replications per location.

Precipitation amounts during the April to August period were 89% and 133% of normal at Sidney in 2004 and 2005, respectively. At Akron, precipitation was 77% and 98% of normal for the April to August period in 2004 and 2005, respectively. Average daily temperatures for the April to August growing season were near normal at both locations in 2004 and 2005.

Triticale forage yield increased by 519 lb/acre for each inch of soil water available at planting in 2004. Foxtail millet forage yield and grain yield of proso millet increased by 903 lb/acre/inch and 188 lb/acre/inch, respectively, in 2004. Spring triticale, foxtail millet, and proso millet did not respond to soil water at planting in 2005, when precipitation was above the long-term average. Dry pea did not demonstrate a consistent positive response to soil water availability at planting.

Results of this study indicated that the amount of plant available soil water at planting may be a suitable indicator of yield potential for selected short-season spring-planted crops. The forage crops in the study, spring triticale and foxtail millet, demonstrated a linear relationship of dry matter accumulation to soil water availability at planting. Proso millet also showed potential as a grain crop for use in a flexible summer fallow cropping system based on soil water at planting. Dry pea did not appear to be suited for such a system. Dry pea yields are unstable and sensitive to temperature and water stress near flowering.

The relationship of soil water at planting to yield is strongest during water-limited years such as 2004. A decision system based on plant available water at planting may underestimate yield when above normal growing season precipitation is received, but the risk of unacceptable yields will be decreased. Additional research will be necessary to further quantify the relationship of plant available water at planting to yield for the crops demonstrating potential for use in a flexible summer fallow system. It may then be possible to develop a decision support tool to determine when to use a short-season spring-planted crop and when to fallow.

Effect of Summer Fallow Replacement Crop on Winter Wheat

The effect of these four summer fallow replacement crops on the subsequent winter wheat crop was evaluated in a continuation of the above study. The results suggests that soil water at the time of planting the summer fallow replacement crop also impacts the subsequent winter wheat crop, although perhaps not to the extent that it affects the summer crop (Table 3). This makes the decision to plant a summer crop or summer fallow prior to winter wheat that much more critical.

The selection of a short-season summer fallow replacement crop may not be as critical as the decision to plant a crop or not, but it still can influence the performance of the subsequent winter wheat crop and the financial return to the farmer. The high cost of dry pea seed, combined with the lack of consistent response of dry pea to soil water at planting makes dry pea a poor choice for a flexible summer fallow cropping system, despite the agronomic benefits that a legume may provide. Although it was only observed at Sidney in 2005-2006, it is intuitive that soil water at winter wheat seeding is likely to be greater following early- rather than late-planted summer crops as a result of the increased time between harvest and winter wheat seeding for the former compared to the latter. It is also likely that soil water at wheat seeding would be greater after a forage crop compared to a grain crop as a result of reduced water use over the shorter growing season and subsequent increased time from harvest to wheat seeding. Since increased soil water at winter wheat seeding is usually positively related to winter wheat yield, it would be reasonable, although not always true, that winter wheat yield would be greater after an early-planted forage crop like triticale compared to a late-planted grain crop like proso millet.

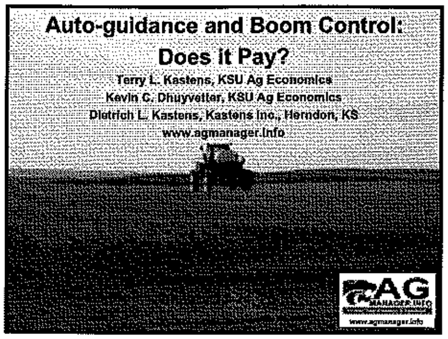
Collectively, these studies suggest that a flexible summer fallow cropping system may be feasible for the northern High Plains. Determining a threshold soil water level at which to plant a summer fallow replacement crop will be critical to the success of the system since it will not only influence the performance of the summer crop but also that of the subsequent winter wheat crop.

Table 3. Influence of previous summer crop and its starting soil water level on the grain yield of the subsequent winter wheat crop at Akron, CO and Sidney, NE in 2004-2005 and 2005-2006.

Treatment	Akron, CO 2004	Akron, CO 2005	Sidney, NE 2004	Sidney, NE 2005
	bu/acre			
Crop				
Triticale	10.2	25.6	22.8	28.6
Dry pea	11.0	25.3	28.3	24.7
Foxtail millet	5.6	---	---	33.5
Proso millet	8.9	---	---	33.2
Soil water level				
Low	4.7	20.4	18.5	27.8
Medium	10.2	23.7	23.1	30.7
High	11.8	32.3	35.1	31.5
Contrasts†				
Early vs late‡	*	---	---	**
Triticale vs dry pea	NS	NS	NS	NS
Foxtail vs proso	NS	---	---	NS
Low vs high	**	**	**	NS

†* and ** indicate a significant difference at the 10 and 5% probability levels; NS indicates no significant difference; --- indicates that crop failure prevented these comparisons.
‡Triticale and dry pea were planted in early April while foxtail and proso millets were planted in early June.

The flexible summer fallow cropping system appears to be most applicable when using short-duration summer annual forage crops, such as triticale and foxtail millet. Forage yield is more readily estimated by soil water at planting than is grain yield and the shorter duration of forage compared to grain crops tends to leave more soil water for the subsequent winter wheat crop. However, grain crops such as proso millet, with low seed cost and a relatively good grain price, may also be feasible if a grower is willing to accept a greater variability in economic return, i.e., greater risk.



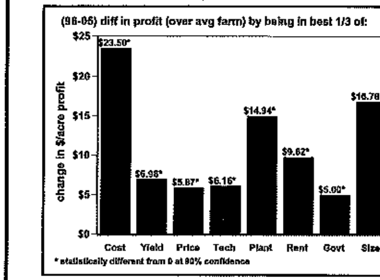
Machinery cost categories

- Repair and maintenance
- Labor
- Depreciation (market, not tax depreciation)
- Interest (opportunity interest)
- Fuel and lubrication
- Taxes, insurance, and shelter

- Custom hire – an excellent proxy for average machinery cost

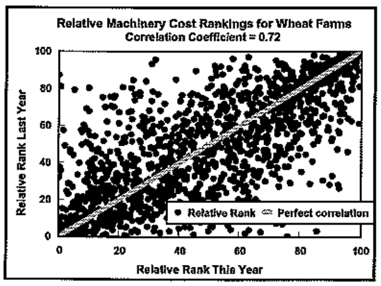
2

Cost differences drive profit differences across farms



Machinery large part of costs, but other stuff matters too

3



Relative machinery costs are somewhat repeatable

4

How important are farm machinery costs for Kansas farmers?

Kansas Farm Management Association Enterprise Analysis Nonirrigated Crops -- State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Average Acres	358	481	325	587	321	49
Costs, $ per Acre						
Seed	$27.46	$45.16	$9.42	$6.38	$23.61	$6.68
Fertilizer	34.53	46.42	22.07	18.81	4.17	8.96
Herb-ins	23.41	41.38	20.21	4.95	16.60	10.53
Crop ins	6.60	11.59	4.17	3.66	5.20	0.24
Machinery	70.26	107.65	58.10	59.19	63.16	80.79
Other	18.70	100.03	16.26	16.00	16.17	21.92
Land	35.90	53.62	18.30	22.68	30.16	44.59
Interest	17.21	32.59	12.58	11.95	14.39	15.49
Total Cost	$234.04	$438.64	$160.12	$143.61	$175.45	$189.20
Machinery, %	30.0%	24.6%	35.9%	41.2%	36.0%	42.7%

5

Machinery costs are highly variable across farms ...

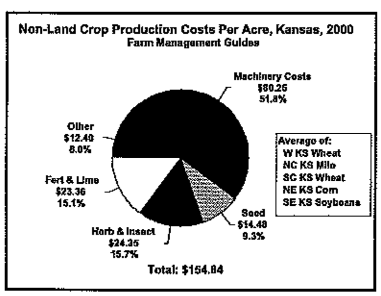
Kansas Farm Management Association Enterprise Analysis Nonirrigated Crops -- State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Average Acres						
High profit farms	512	552	446	742	452	87
Mid profit farms	325	525	321	633	329	192
Low profit farms	231	362	207	388	183	70
Machinery Costs, $/acre						
High profit farms	$52.07	$88.51	$44.16	$48.57	$50.73	$64.04
Mid profit farms	$64.48	$105.38	$54.26	$53.51	$61.04	$80.62
Low profit farms	$94.40	$129.28	$69.88	$75.55	$77.71	$97.68
High less low, $	-$42.34	-$40.77	-$25.72	-$26.98	-$26.98	-$33.64
High less low, %	-44.8%	-31.5%	-36.8%	-35.7%	-34.7%	-34.4%

6

Machinery costs are important in explaining profitability differences across farms ...

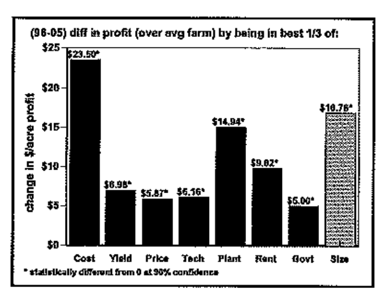
Kansas Farm Management Association Enterprise Analysis Nonirrigated Crops -- State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Machinery Costs, $/acre						
High profit farms	$52.07	$88.51	$44.16	$48.57	$50.73	$64.04
Mid profit farms	$64.48	$105.38	$54.26	$53.51	$61.04	$80.62
Low profit farms	$94.40	$129.28	$69.88	$75.55	$77.71	$97.68
High less low, $	-$42.34	-$40.77	-$25.72	-$26.98	-$26.98	-$33.64
High less low, %	-44.8%	-31.5%	-36.8%	-35.1%	-34.7%	-34.4%
Differences between high profit farms and low profit farms in ...						
Net returns	$108.15	$158.42	$79.74	$80.72	$79.16	$141.93
Total costs	-$101.66	-$106.81	-$65.87	-$52.98	-$58.78	-$78.16
Cost/net returns	94.3%	67.4%	82.7%	65.6%	74.3%	55.1%
Mach/total costs	41.6%	38.2%	39.0%	51.0%	45.9%	43.0%
Mach/net returns	39.1%	25.7%	32.2%	33.4%	34.1%	23.7%

7



Last year machinery costs were split out in Farm Management Guides was 2000

8



Machinery large part of costs, but other stuff matters too

9

- Adopting new machinery technologies is an important way that farm managers lower their machinery costs to distinguish themselves from others for the purpose of increasing profit.
  - Using GPS to assist machinery operations is an especially important new technology.

10

General machinery overlap issues

- Extra machine operation
  - Increases machinery costs since overlap areas are covered more than once, so more acres have to be farmed than which are in the field
- May affect applied input usage
  - Increases crop input cost since overlap areas are covered more than once and thus get more seed, fertilizer, herbicide, etc.
- These are *cost* issues

11

Field headland issues (where the action is)

- Headlands cause economic problems:
  - Increase cost of machine operations
    - Doubling up of machine operations
    - Machines need to slow down for turnaround
  - Increase crop input costs due to doubling up
  - Double-planting, -applying, -tilling, and extra compaction can reduce crop yield, thus revenue
- Portion of field covered by headlands:
  - Affects *costs* and *revenues*
  - Greatly affected by field size and shape
  - Especially affected by width of machine

12

Large (wide) machine issues

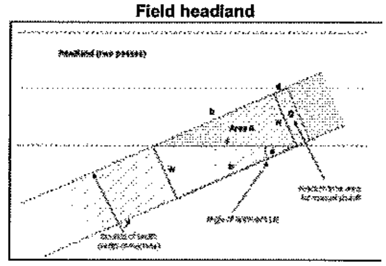
- Need large turnaround area, increasing headland size
- Can we make the larger machines behave as though they were smaller, at least in terms of the portion of a headland affected by input doubling-up?
  - boom or section shut-offs

13

- Regardless, all situations are quite site- and machine-specific
  - Hard to make general rules of thumb across farms
  - Requires individual-situation analysis
    - So, we developed a decision tool (an Excel spreadsheet) to aid such decisions, called
    - KSU-GPSguidance.xls (at www.agmanager.info)
- To get some understanding, we will report some economic results for one particular farm (the Kastens farm)

14

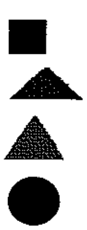
Field headland



Areas A and Q and turnaround counterparts will have a) doubling-up of inputs and b) possible yield losses due to this doubling-up.
After the turnaround there will be overlap along b, also accounted for.

15

Various field shapes of interest (farm left to right)



Square; hit ends at 90 degree angles
5,280 feet of headlands in 160 acre field

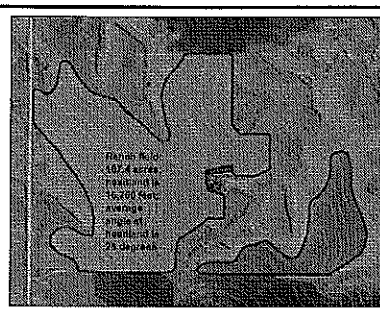
Isosceles right triangle; hit ends at 60 degree angles
7,467 feet of headlands in 160 acre field

Equilateral triangle; hit ends at 45 degree angles
8,024 feet of headlands in 160 acre field

Circle; hit ends at angles varying from 0 to 90 degrees (avg. 40 degrees) 9,359 feet of headlands in 160 acre field

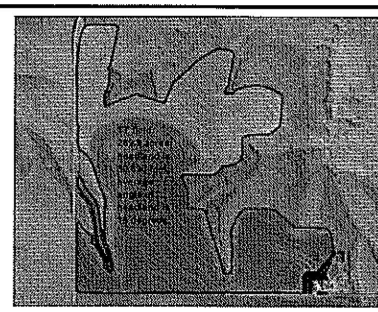
Kastens fields average hitting headlands at around 24 degrees

16



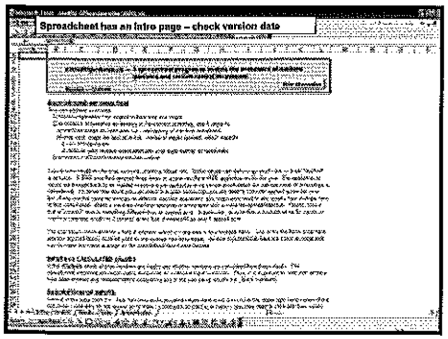
A Kastens field that is much less efficient than squares, triangles, or circles

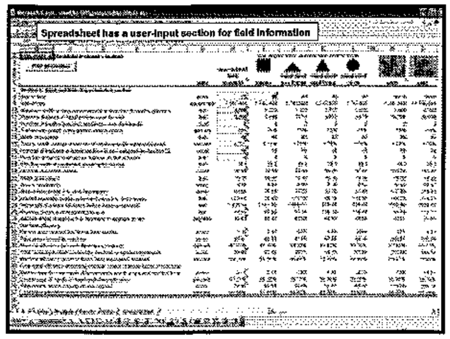
17

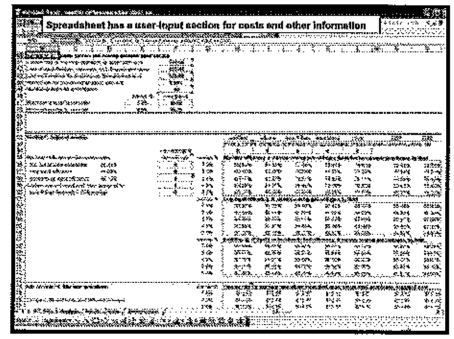


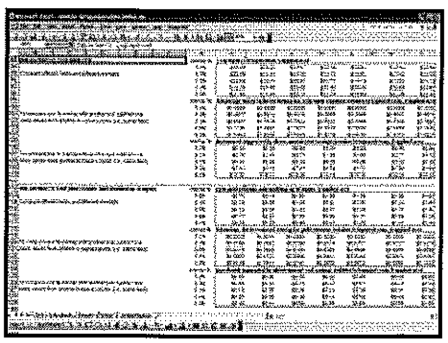
Another extremely inefficient Kastens field

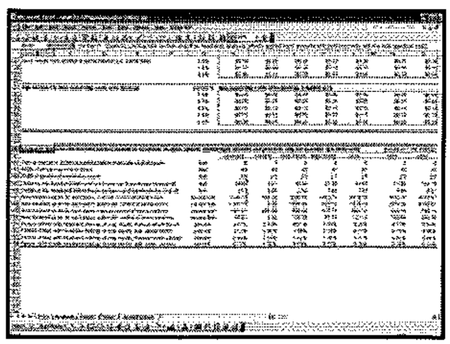
18

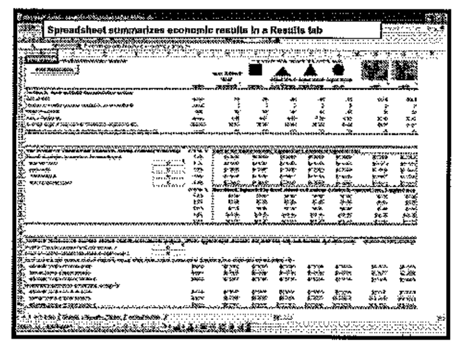


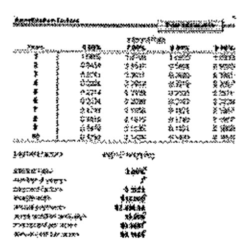












At 8.00% and 7 years could invest about 5x the annual amount per acre

25

Reporting a few results from Kastens farm

- "Typical field" is 92.26 acres
  - 1874 feet distance perpendicular to line of travel
    - Same-sized square field 2005 feet
  - 9216 feet running distance of headlands
    - Same-sized square field 4009 feet
  - Headland angle 24 degrees
    - Same-sized square field 90 degrees
  - Much like the Ranch field (odd1), only smaller
- Other universal assumptions:
  - Base custom rate is for typical Kastens field
    - Other fields would have lower base costs
  - amortization of 8.00% interest over 7 years
  - Manual reaction distance (machine up) 5 feet
  - Turnaround speed 75% of down-row speed
  - GPS subscription fee (or hassle factor) cost $0.20/acre at 0% overlap to $0.00/acre at top overlap considered

26

- Undercutter or field cultivator example
  - 40 foot wide
  - 2 passes to cover headland
  - $6.50/acre custom rate
  - Assume lost yield revenue on doubled-up headland acres is $35/acre for the year on wheat
    - Say 10 bu/acre at $3.50/bu
    - But, use machine 5 times prior to planting, so yield revenue lost per application on doubled-up acres is $7/acre

27

Using tractor on a 40-ft undercutter or field cultivator

Ignoring everything else, save $0.2280/acre taking overlap from typical no-marker value of 7% to say, 1.8% with a reasonable autoguidance setup. This would allow an investment of $1.18/acre or $11,900 on 10,000 acres (i.e., 2,000 acres of summerfallow wheat, farmed 5 times in preparation for planting).

Notice that more complex field shapes induce LESS benefit to overlap reduction rather than more – such fields have more of their machines' field time spent on intrinsic inefficiencies related to headlands that are not impacted by reduced overlap.

28

Using tractor on a 40-ft undercutter or field cultivator

Bringing in the assumed $0.15/acre ($1,500 on 10,000 acres) annual GPS subscription fee or hassle factor, reduces the investment that could be made to get to 1.8% overlap to $4,100 on 10,000 acres (i.e., $0.41/acre).

29

Using tractor on a 40-ft undercutter or field cultivator

Bringing in also the $7/acre/operation lost yield revenue on doubled-up headland acres supports an investment of $5,000 in this 2000 acres of annual summerfallow wheat situation.

30

- **Sprayer example**
  - 90 foot wide
  - 1 pass to cover headland
  - $4.25/acre custom rate
  - $10.00/acre/application of chemical used
  - Assume lost yield revenue on doubled-up headland acres is $30/acre/year on corn (12 bu/acre at $2.50)
    - Assign loss half to spraying excess chemicals and half to double-planting with planter, so $15 for sprayer/yr.
    - But, apply 3 times prior to planting (say twice after wheat harvest, once in spring), so yield revenue lost per application on doubled-up acres is $5/acre.

31

90-ft sprayer example

Ignoring everything else, save $0.1452/acre taking overlap from typical foam-marker value of 7% to say, 1.8% with a reasonable autoguidance setup. This would allow an investment of $0.76/acre, or $11,400 on 15,000 acres of annual sprayings.

32

90-ft sprayer example

Bringing in the input cost savings increases the investment that could be made to support going from 7% to 1.8% overlap to $3.05/acre (over $45,000 on 15,000 acres/yr sprayed).

33

90-ft sprayer example

Bringing in everything we consider changes the investment that could be made to support going from 7% to 1.8% overlap to $2.41/acre ($36,150 on 15,000 acres/yr sprayed).

34

- **Sprayer example – boom shutoff**
  - We now consider the benefits for automatic boom section shutoff at the headlands
  - We start with the assumption of a default overlap percentage of 1.8% as the one determining custom rates, and then consider:
    - Automatic (GPS) control of whole boom
    - Manual control of each of 5 boom sections independently (you'd better be fast acting)
    - Automatic (GPS) control of 5 boom sections

35

90-ft sprayer example – boom shutoff control, 5 sections

Going to automatic boom shutoff control saves $1.2226/acre per year, and thus supports an investment of $95,000+ in this 15,000 acres/year scenario. Note, that the GPS component of this technology may not have to be "covered" by savings here if it is already justified via the autoguidance investment. This is obviously the place to focus GPS investments for Kansans.

Even if yield loss component is ignored, the justified investment is $63,000+.

Notice the huge benefits to this technology for more irregular fields (compare Ktypical with square field).

Keep in mind that most of this "gain" could come from manual control of the 5 sections, which typically the sprayer already comes with. But, can you really manually control 5 sections effectively? If not, then the investment noted above is merited.

36

- **Planter example**
  - 40 foot wide (16 rows 30 inches)
  - 2 passes to cover headland
  - $12.50/acre custom rate
  - $25.00/acre seed cost
  - Assume lost yield revenue on doubled-up headland acres is $30/acre for the year on corn (12 bu at $2.50)
    - Assigned half to sprayer operations
    - So, $15/acre for planter

37

Planter example

[illegible]

Bringing in everything we consider, going from a 2.0% overlap (e.g., marker-based guidance) to 0.5% guidance (fairly good GPS guidance), saves $0.3255/acre, which supports an investment of $1.69/acre, or $5,070 if the planter plants 3,000 acres of corn per year.

38

- **planter example – section shutoff**
  - We now consider the benefits for automatic section shutoff at the headlands
  - We start with the assumption of a default overlap percentage of 1.0% as the one determining custom rates, and then consider controlling:
    - 2 sections (8 rows each)
    - 4 sections (4 rows each)
    - 8 sections (2 rows each)
    - 16 sections (i.e., individual row shutoff)
  - In our investment analysis, we'll assume the operator already effectively controls 2 sections manually

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Planter example – section shutoff control, 2 sections

[illegible]

Going from manual to automatic section control of planter (2 sections; 8-rows controlled together) saves $0.1884/acre/year (from $1.0349-$0.8466), which happens to be the same thing as the auto-control of whole boom number, supporting an investment of $2,942 on 3000 acres ($0.9807/acre). Comparable numbers (tables not shown) for more sensitive control (relative to manual 8-row control) are:

4-row control, $0.6117/acre/yr savings, $ 9,553 investment supported
2-row control, $0.8233/acre/yr savings, $12,858 investment supported
1-row control, $0.9291/acre/yr savings, $14,512 investment supported

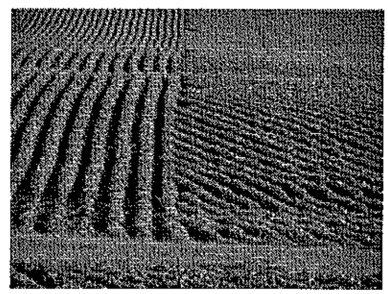
If all headland yield loss assigned to planter rather than half to sprayer:

1-row control, $1.2775/acre/yr savings, $19,954 investment supported

Like the sprayer, big benefits to section control for irregular fields
Why is this not yet an option on planters?

40

41



42

Additional thoughts/considerations

- In the planter example, assume:
  - 1% overlap (so assume autoguidance)
  - $1.78/acre/year benefit to individual row control over manual whole-planter control (the $1.78 here compares with the $0.9291 number on previous slide)
  - (1) No section control of planter
    - Typical (acres-weighted) machine cost or custom rate is $12.50/acre; rates range from $11.65/acre to $17.95/acre across the 75 fields, with a standard deviation of $1.41.
  - With 16-section (each row) control & sunk investment
    - (2) For owner-operator (gets input benefits)
      - Typical "cost" is now $10.72/acre (i.e., $12.50-$1.78)
      - Appropriate "machine" costs (brings in input and yield loss savings) across the 75 fields range from $10.52/acre to $12.35/acre, with a std dev of $0.38/acre.

43

Planter section control, cont'd

- With 16-section (each row) control & sunk investment
  - (3) If custom operator can extract a producer's benefits (but not the added cost of farming irregular fields):
    - Typical charge is $14.28/acre (i.e., $12.50+$1.78); ranges from $13.63 to $18.35, with a std dev of $1.03/acre.
  - Either scenario 2 or 3 reduces variability and increases profit relative to no section control of planter.
  - (4) If custom operator can extract a producer's benefits and appropriately charge for the differences in machinery cost across irregular fields:
    - Typical charge is still $14.28/acre, but charges now range from $12.78 to $23.78, with a std dev of $2.44/acre.
    - Increases profit and increases variability relative to no section control
  - Think about how you would sell the "service"

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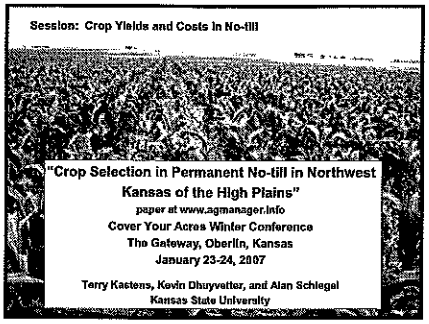
Summary

- Lowering machinery costs is where the action is.
- Keep in mind that a tractor is multi-purpose, so GPS benefits can be additive.
- Think carefully about expected yield losses on doubled-up headland acres.
- Field size and shape doesn't much impact benefits to GPS autoguidance,
  - but really impacts benefits to section shutoff.
  - Autoguidance and section control share GPS items.
- GPS technologies should help to differentiate custom rates and ultimately land rental rates by field size and shape.
  - Section control may help stabilize these numbers.
- We didn't account for reduced operator fatigue.

45

Session: Crop Yields and Costs in No-till



At 2006 "Cover Your Acres" we talked about . . .

- No-till is increasing in High Plains
- No-till is profitable
- Permanent no-till has additional benefits
  - i.e., no-till also ahead of the wheat crop
  - This merits a repeat
- Remember, we best learn when our biases and preconceptions are challenged, not when we merely seek out results that confirm those biases

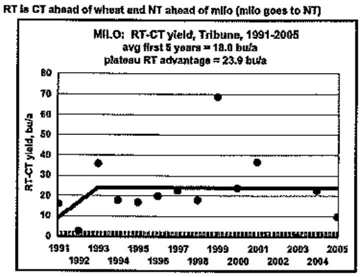
2

Tribune Kansas WMF rotation (NT vs. CT)

- Wheat
  - NT has 18% more ASW at planting
  - NT has 26% higher grain yields
  - NT has 23% higher WUE
  - NT ASW grows at 0.16 in. per year
  - NT WUE grows at 1.36 lb/in. per year
  - NT yield might grow 1 bu/acre per year
    - Using model of water on yield and growth in ASW and WUE
- Milo
  - NT has 28% more ASW at planting
  - NT has 95% higher grain yields
  - NT has 101% higher WUE
  - NT ASW grows at 0.09 in. per year
  - NT WUE grows at 10.15 lb/in. per year
  - NT yield might grow 3 bu/acre per year
    - Using model of water on yield and growth in ASW and WUE

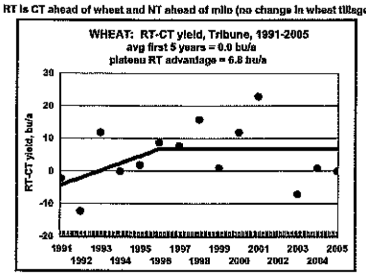
3

RT is CT ahead of wheat and NT ahead of milo (milo goes to NT)



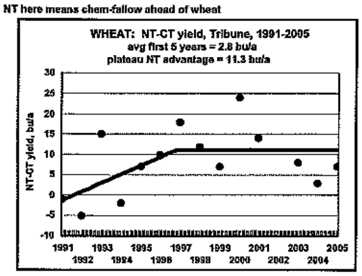
Don't need patience (immediate gains from NT on milo) 4

RT is CT ahead of wheat and NT ahead of milo (no change in wheat tillage)



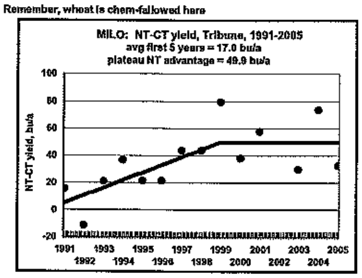
Must have a little patience here on the wheat leg (really, accidental) 5

NT here means chem-fallow ahead of wheat

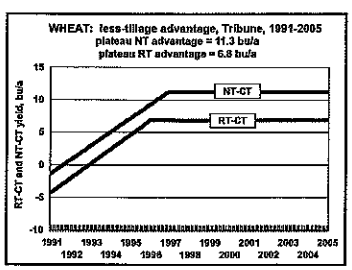


This is the "hard" part (hard ground; chemical vs. tillage $) 6

Remember, wheat is chem-fallowed here

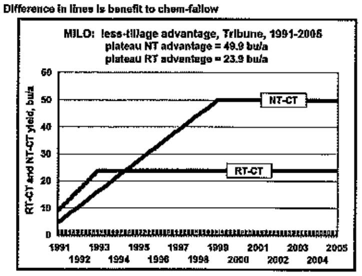


Milo yields continue to increase longer when wheat chem-fallowed 7



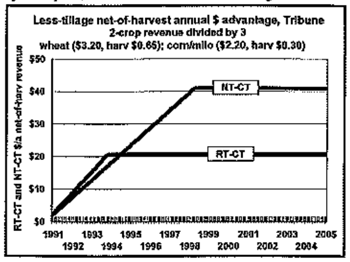
NT-over-RT: 4.5 bu/a (HUGE in this 35 bu/a environment) 8

Difference in lines is benefit to chem-fallow



9

Okay to compare $ if cost of chem-fallow similar to tillage-fallow cost

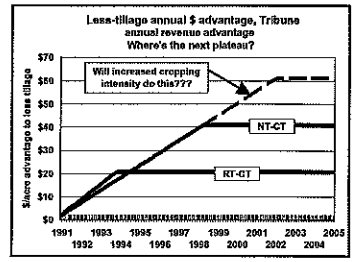


10

Change in NT over CT advantage over time

- NT-CT yield difference appears to have grown for about 8-10 years, then leveled
- Do changes in soils and residue that improve water use stop after 8-10 years?
- Or, are we "leaving water on the table," implying that cropping intensity should be increased?
  - A potential advantage somewhat unique to drier areas of the country

11



12

What to think about . . .

- If you are currently in a wheat-milo-fallow CT program, move at least to ecofallow (i.e., NT ahead of milo), since well-proven:
  - Will gain 24 bu/a on milo nearly immediately
  - Will gain 6+ bu/a on wheat in 5-8 years
- Then think about continuous NT, i.e., chem-fallow on the wheat:
  - Will pick up *another* 4 bu/a on wheat in about 6-7 yrs
  - Will pick up *another* 28 bu/a on milo in about 7-9 yrs
- Then (or better yet, simultaneously) think about intensifying rotation:
  - To prevent "leaving water on the table"

In 2006, we should have added, "What about corn?"

13

The Problem

- Field research completed in "good" years suggests more corn and increased cropping intensity
- Field research completed in "tough" years suggests more wheat and more fallow
- Decisions always are made for next year and beyond
- Weather drives profitability and we remember recent weather
- What should we do if we consider a broader array of weather?

14

The Problem

- Schlegel's tillage study accomplished a lot
  - Challenges our bias about permanent no-till
- Can we extend its inferences to
  - Other crops (e.g., corn)?
  - Other areas in NW Kansas (Colby, Atwood)?
  - Other time periods (weather)?
- Think of this work as "pushing" Schlegel's findings as far as we dare
  - Especially to weaken the recency effect
  - We do run the risk of going "too far"

15

Mathematical Model

- $ASW_{plant} = f(ASW_{harv}, \text{rain, water loss})$
- $Yield = f(ASW_{plant}, \text{rain, water loss})$
- $ASW_{harv} = f(ASW_{plant}, \text{rain, water loss, Yield})$
- Corn yields are determined by milo yields

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Table A1. Data from Schlegel's tillage study of wheat-milo-fallow near Tribune, Kansas, 1991-2005, no-till only.

	Wheat				Milo			
	ASW prev harv	ASW planting	harvest yield	ASW harvest	ASW prev harv	ASW planting	harvest yield	ASW harvest
year	inches	inches	bu/acre	inches	inches	inches	bu/acre	inches
1991	0.33	2.54	15	1.38	9.00	4.91	39	0.40
1992	1.77	4.06	21	1.82	1.36	7.96	27	1.41
1993	0.40	8.23	58	0.76	1.82	5.89	68	2.36
1994	1.41	9.74	46	3.41	0.76	7.64	57	3.29
1995	2.38	4.21	56	3.28	3.41	9.97	59	2.37
1996	3.29	9.37	26	6.29	3.28	3.97	119	3.12
1997	2.37	9.77	52	3.02	6.39	9.24	115	13.44
1998	3.12	9.06	64	0.72	3.02	12.33	131	2.83
1999	13.44	10.44	43	3.33	0.72	7.56	99	5.23
2000	2.83	12.57	45	1.25	3.33	8.68	58	2.10
2001	5.23	5.81	31	2.97	1.25	9.00	64	1.13
2002	2.10	9.27	0	4.45	2.97	2.93	0	1.58
2003	1.32	2.40	30	3.06	4.45	7.11	37	1.64
2004	1.58	6.18	4	4.31	3.06	4.59	116	3.44
2005	1.64	8.13	39	3.03	4.31	7.28	61	3.07
avg.	2.88	7.52	37.93	2.87	2.69	7.31	69.67	3.16

Unsure how much ASW correlates with 6-foot ball rod measurements

17

Simulation was calibrated to 1991-2005

- We assume a good no-tiller in Colby or Atwood would do proportionately as well as Schlegel did in his county relative to the county averages

Mean 1991-2005 NASS and NT yield targets for calibrating simulation

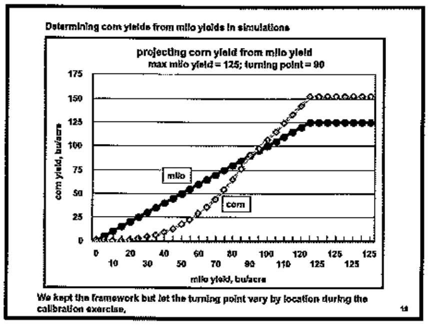
	NASS yields			NT yield targets in WMF or WCF rotation		
	Greeley Co.	Thomas Co.	Rawlins Co.			
	Tribune	Colby	Atwood	Tribune	Colby	Atwood
Wheat	27.99	31.47	34.32	37.93	42.55	46.00
Milo	46.11	54.36	49.08	69.67	76.72	71.06
Corn	46.85	52.26	53.46	67.83	75.67	77.44

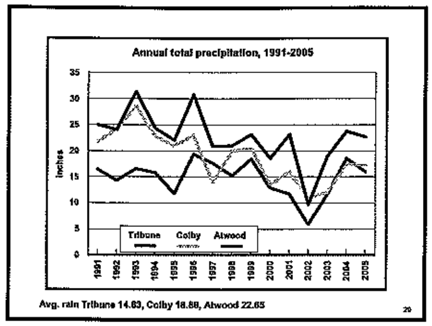
NASS yields are for wheat following fallow, and non-irrigated totals for milo and corn
NT targets for Tribune wheat and milo are mean yields in Schlegel's study

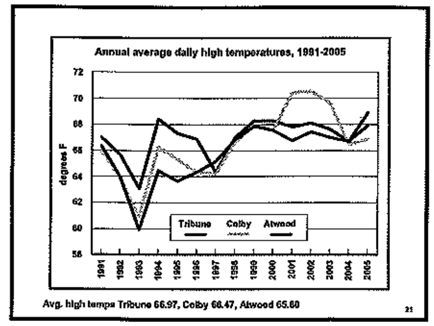
Notice the fairly "high" corn and milo yields targeted for the permanent no-tiller in Colby and Atwood during the time – despite drought in the 2000s. Notice also the corn-milo reversals between Colby and Atwood.

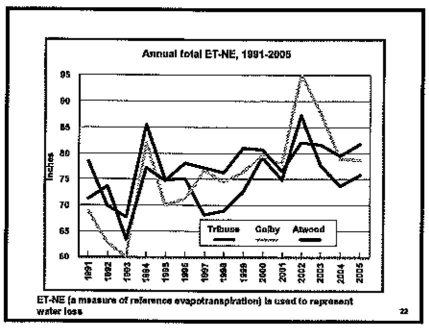
We calibrated models so observed weather gave targeted yields on average.

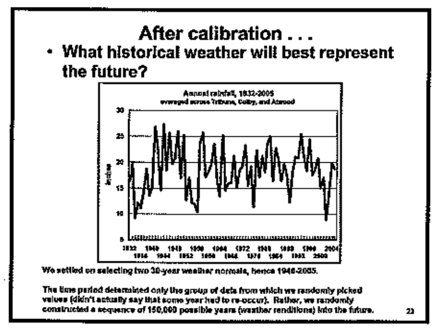
18

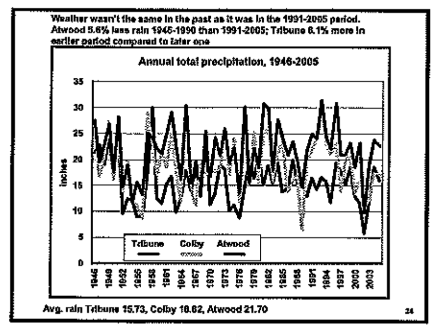


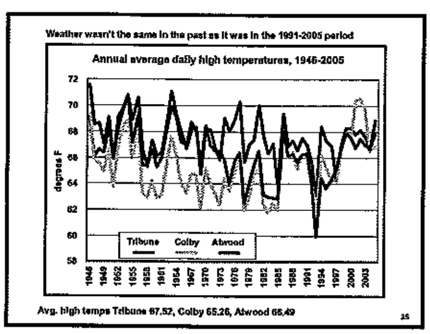


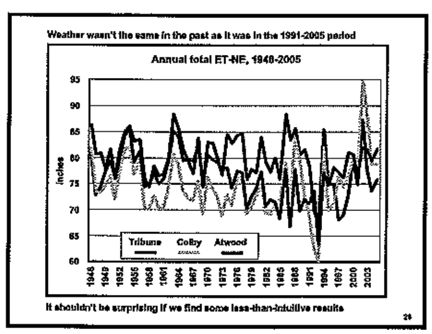












Rotations examined

- **WMF** wheat-milo-fallow
- **WCF** wheat-corn-fallow
- **WCMF** wheat-corn-milo-fallow
- **Opp** based on ASW_{plant} opportunity
- **WF** wheat-fallow
- **WW** wheat-wheat
- **MM** milo-milo
- **CC** corn-corn
- **CM** corn-milo

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Opp considered here

- Following wheat
  - Wheat planted back that fall if ASW>5 then
    - Else corn next spring if ASW>6 then
      - Else milo next spring if ASW>4 then
        - Else plant wheat next fall
- Following corn
  - Wheat planted into stalks if ASW>3 then
    - Else corn next spring if ASW>5 then
      - Else milo next spring if ASW>4 then
        - Else plant wheat next fall
- Following milo
  - Plant corn next spring if ASW>5 then
    - Else milo next spring if ASW>4 then
      - Else plant wheat next fall

Could have considered *many* more – this one had around 65%-90% intensity 28

Crops with different expected yields

- WaF wheat after long fallow (as in WF)
- WaM wheat after milo (as in WMF)
- WaC wheat after corn
- WaW wheat after wheat (as in WW)
- WaS wheat planted into corn stalks
- MaW milo after wheat (as in WMF)
- MaM milo after milo
- MaC milo after corn
- CaW corn after wheat (as in WCF)
- CaM corn after milo
- CaC corn after corn

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Economic assumptions

- Cash prices (expected 3-year avg at Colby)
  - Wheat \$4.43, Corn \$3.29, Milo \$2.86
  - No variation in simulations
- Liquid fertilizer applied at crop removal rates
  - N at \$0.33/lb N; P at \$0.30/lb P_2O_5
- Harvest at 2005 custom rates + 5%
- Plant \$12.50/acre; apply chemicals \$4.35/acre
- Herbicide cost from Kastens Farm
- Assume a 65% actuarially fair crop insurance
- Rent is \$35/acre in all locations (govt \$12)
- Risk: standard deviation and worst6

30

Table A5. Cost of herbicide and application, fertilizer application, seed, and planting.

crop[a]	herbicide $/crop acre	no. of herbicide applications per crop acre @ $4.35 per applied acre	no. of fertilizer applications per crop acre @ $7.00 per applied acre	seed $/crop acre[b]	total non-fertilizer costs $/crop acre
WaF	19.93	5.25	1	7.00	69.29
WaM	13.36	3.5	1	7.00	55.03
WaC	13.30	3.5	1	7.00	55.03
WaW	10.60	3	1	7.00	50.15
WaS	0.00	0	1	10.50	30.00
MaW	28.34	3.75	0	5.00	62.15
MaM	25.53	2	0	5.00	51.73
MaC	25.53	2	0	5.00	51.73
CaW	26.44	2.75	0	25.00	75.90
CaM	19.79	1	0	21.05	57.69
CaC	19.79	1	0	21.05	57.69

[a] WaF is wheat after long-fallow, as in a wheat-fallow rotation, WaW is continuous wheat, WaM, WaC, MaW, CaW depict the typical crops in a wheat-milo-fallow or wheat-corn-fallow rotation. WaS is wheat after a spring crop, as in wheat planted immediately following corn harvest (into corn stalks). MaM, MaC, CaM, CaC represent milo-milo rotations, milo-corn, corn-milo, and corn-corn.
[b] All crops are assigned a planting charge of \$12.50/acre (included in the totals in right column).

Management matters: MaW has about \$1/acre/year more herbicide than CaW

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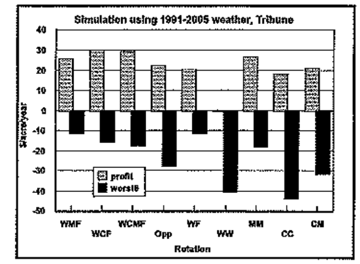
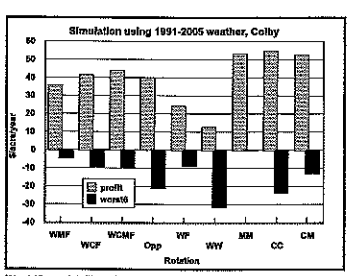
Before we look at long-run 1946-2005 . . .

- Permanent NT targeted yields suggested
  - Tribune: milo 69.7 bu/acre, corn 67.8 bu/acre
  - Colby: milo 78.7 bu/acre, corn 71.1 bu/acre
  - Atwood: milo 75.7 bu/acre, corn 77.4 bu/acre
  - Wheat: Tribune 37.9, Colby 42.5, Atwood 46.0
- Wheat especially good in Atwood
- Corn better than milo in Atwood
- Milo better than corn in Colby
- Remember, these are permanent NT yields
  - Bumps both wheat and row crop yields

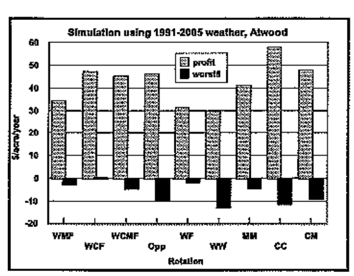
32



If had 15-year intuition with permanent NT, this might be what you'd think 33

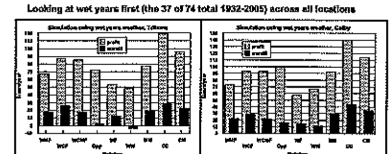


If had 15-year intuition with permanent NT, this might be what you'd think 34



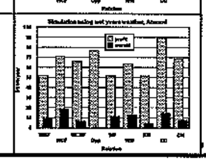
If had 15-year intuition with permanent NT, this might be what you'd think 35

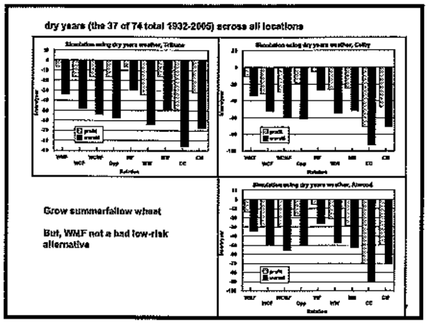
Looking at wet years first (the 37 of 74 total 1932-2005) across all locations

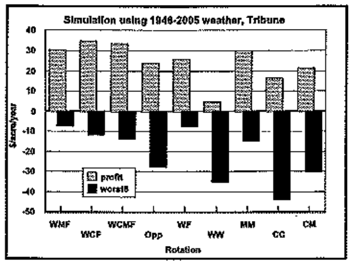


Added annual rainfall together for the 3 locations, then picked out the wettest 37 of the 74 years

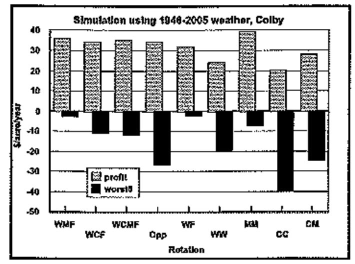
Grow corn



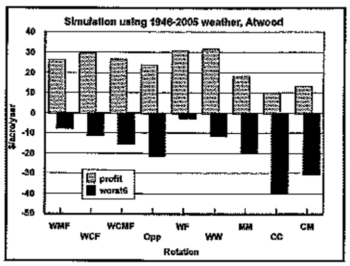




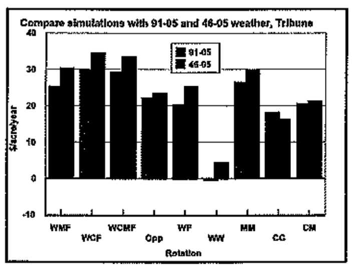
Think about very little WW, more row crops, more intensity? 38



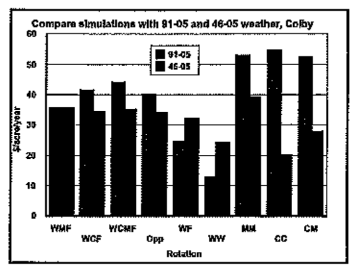
Think about more row crops, more intensity, maybe more MM? 39



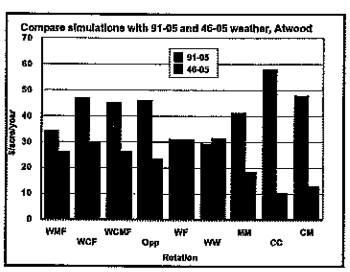
Think about more wheat? 40



1991-2005 intuition may serve you well in the future 41



1991-2005 intuition not terrible but likely would over-rate intensity some 42



1991-2005 intuition may not serve you very well in the future 43

Caveats

- No consideration of
  - Crops like sunflowers and soybeans
  - "New" crops like canola or peas
- Ignored idea that permanent no-till improves yields over time, perhaps disproportionately
- Reflects relative technology in 1991-2005
  - Corn benefits more from technology
  - Adequate account of biofuel craze?
- Continuous crops did not consider disease & weeds
- Increased global warming or cooling would negate our efforts

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Summary

- Adding more years of weather as a predictor for the future can negate our intuition
- No holy grail
- WMF & WCF likely around for awhile
- Surprises
  - Opp not particularly great
  - WW bad in Tribune, good in Atwood
  - WF still holding its own
- Recommendations
  - Focus main effort on more important tasks, for example machinery management
  - Then focus on tweaking crop rotations

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Natural Resources Conservation Service
Farm bill Programs
Clinton J. Evans, Resource Conservationist

Environmental Quality Incentives Program (EQIP)

- What is EQIP?
- Resource concerns
- Eligibility requirements for the participant
- Eligibility requirements for the land
- Management incentives – residue management, nutrient management and pest management
- Conservation practice adoption
- Questions?

Conservation Security Program (CSP)

- Fundamentals of CSP
- Watershed approach
- Eligibility requirements for the participant
- Eligibility requirements for the land
- Three-Tiered Program
- Payment components
- Enhancement activities – air management, energy management, soil management, nutrient management, and pest management
- Compatibility of EQIP and CSP
- Questions?

Getting the Most Out of Glyphosate

Dallas Peterson
Department of Agronomy
K-State Research & Extension

Glyphosate Issues

- ❖ Product Confusion & Appropriate Rates
- ❖ Factors that Affect Performance
- ❖ AMS Requirements and Replacement Products
- ❖ Application Timing and Yield Protection
- ❖ Expanded Crop Uses
- ❖ Weed Shifts and Glyphosate Resistant Weeds

New Glyphosate Products

- ❖ Many glyphosate products
- ❖ Different concentrations, formulations, and adjuvant requirements
- ❖ Need to read labels carefully and follow rate and adjuvant recommendations
- ❖ KSU research: few or no differences among most glyphosate products when applied at same acid equivalent rates and with recommended adjuvants.

Active Ingredient (a.i.) vs. Acid Equivalent (a.e.)

- ❖ Glyphosate acid is the active form of glyphosate in plants.
- ❖ Nearly all glyphosate products formulated as salts, ie. isopropylamine (IPA), diammonium (DA), or potassium (K).
- ❖ Salt portions of formulated molecules have different weights.
- ❖ Active ingredient weight includes the salt part of the molecule, while acid equivalent weight does not.
- ❖ Acid equivalent weight provides a better comparison of the herbicidal component of the different glyphosate salts.

Glyphosate Products

Trade name	Salt	lb ai/gal	lb ae/gal	0.75 lb ae/A
Roundup Original	IPA	4	3	1 qt
Roundup Original MAX	K	5.5	4.5	22 oz
Roundup WEATHERMAX	K	5.5	4.5	22 oz
Touchdown	DA	3.75	3	1 qt
Touchdown Total	K	5	4.2	24 oz
Touchdown HiTech	K	6	5	19 oz
Durango	IPA	5.4	4	26 oz
Glyphomax XRT	IPA	5.4	4	26 oz
Most Generics	IPA	4	3	1qt

Surfactant Requirements with Glyphosate

- ❖ Some glyphosate products always recommend using surfactant, some indicate the addition of surfactant is optional, while other products do not need additional surfactant.
- ❖ READ THE LABEL.
- ❖ KSU generally recommends adding a source of ammonium sulfate to all glyphosate applications, to condition the water carrier.

Application Factors

- Environment
  - Temperature
  - Humidity
  - Drought Stress
- Rainfree Interval
- Time of Day
- Spray Volume
- Water Quality
- Water Conditioners
- Dust
- Wheel Tracks
- Weed Factors

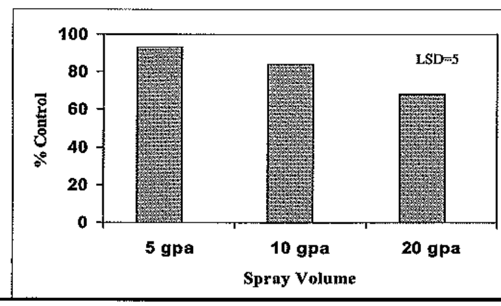
The influence of application time of day on glyphosate performance, Manhattan, KS, 1999.

Application Time of Day	Palmer amaranth Post	Palmer amaranth LP	Velvetleaf Post	Velvetleaf LP
	(% control)			
6:00 am	96	85	96	47
10:00 am	99	100	99	99
1:30 pm	100	100	99	99
5:00 pm	100	99	97	97
9:00 pm	99	88	95	47
LSD	3		9	

Application Time of Day

- Weed control with Roundup was less when applied pre-dawn or post sundown than during the middle of the day.
- Possible reasons:
  - presence of dew
  - light influence on physiological interactions
  - plant leaf orientation

Oat control 2 WAT with a reduced rate of glyphosate as influenced by spray volume, Manhattan, KS 2001.



AMS Replacements with Glyphosate

AMS Replacements with Glyphosate Materials & Methods

- Spray Volume: 15 gpa
- Water Hardness: 103 Total Hardness as $CaCO_3$ ~6 grains/gal
- Application: 7/12/05, 89F, 55% RH
  - Velvetleaf: 6-12" 5-10 leaf
  - Sorghum: 16" V6
  - Corn: 20" V6
  - Sunflower: 12-16" 8-10 leaf

Weed control with glyphosate plus AMS replacement adjuvants at 4 WAT, Manhattan, KS (MS200508).

Treatment	Rate	Velvet-Leaf	Sorghum	Corn	Sun-flower
		(% control)			
Roundup WMax +:	8 oz +:				
None		40	60	52	73
AMS	2 % w/w	77	90	83	92
Class Act NG	2.5% v/v	72	90	82	90
Alliance	1.25% v/v	65	83	77	90
Choice	0.5% v/v	30	47	42	60
Request	0.5% v/v	37	58	50	75
Speedway	0.5% v/v	42	50	50	85
Blendmaster	1% v/v	43	57	53	80
US 500	0.25% v/v	33	50	47	70
Citron	2.2 lb/100G	37	40	40	78
N-Tank	0.5% v/v	62	68	67	90
LSD (10%)		7	9	7	7

Weed control with glyphosate plus AMS replacement adjuvants at 4 WAT, Manhattan, KS , 2006 (MS200606).

Treatment	Rate	Velvet-Leaf	Sorghum	Corn	Sun-flower
		(% control)			
Roundup WMax +:	8 oz +:				
None		0	0	0	3
AMS	2 % w/w	50	67	70	85
Class Act NG	2.5% v/v	30	73	68	78
Alliance	1.25% v/v	17	57	57	43
Choice WM	0.5% v/v	3	0	0	5
Request	0.5% v/v	8	0	7	7
Flame	0.5% v/v	5	2	3	10
Cayuse Plus	0.5% v/v	10	5	3	7
Loadout	0.5% v/v	3	3	3	7
Citron	2.2 lb/100G	3	3	5	3
N-Tank	0.5% v/v	30	22	37	23
LSD (10%)		10	9	10	11

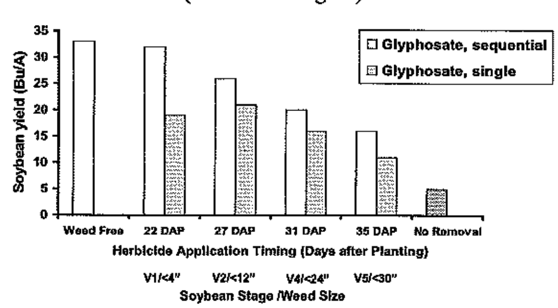
Weed control with glyphosate plus AMS replacement adjuvants at 9 DAT, Tribune, KS 2006 (0613Fall).

Treatment	Rate	Sorghum	Corn	Sunflower
		(% control)		
Roundup WMax +:	8 oz +:			
None		56	74	84
AMS	2 % w/w	83	90	89
Class Act NG	2.5% v/v	80	87	90
Alliance	1.25% v/v	83	78	90
Choice WM	0.5% v/v	63	69	85
Request	0.5% v/v	60	73	85
Flame	0.5% v/v	69	84	86
Cayuse Plus	0.5% v/v	69	86	86
Loadout	0.5% v/v	68	78	86
Citron	2.2 lb/100G	69	80	86
N-Tank	0.5% v/v	83	86	87
LSD (10%)		16	11	5

Weed Control and Yield Protection

- Weed Pressure
- Weed Control Strategy
- Timing of Weed Control
- Level of Weed Control

Soybean yield as influenced by time of weed removal, 1998. (Peterson&Regehr)



Critical Period of Weed Control

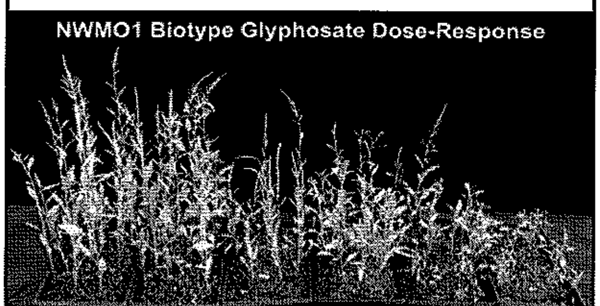
- Growth Stage or critical period to remove weeds from a crop before significant yield loss occurs.
- Highly variable and dependent on:
  - Weed Species Present
  - Weed Populations
  - Time of Weed Emergence Relative to Crop Emergence
  - Crop Management Practices
    - fertility, row spacing, population, etc
  - Environmental Conditions
- Often 3 to 4 WAP with heavy weed pressure

Hard to Control Weeds with Glyphosate

- Naturally Tolerant Species:
  Prairie cupgrass, tumble windmillgrass, yellow nutsedge, annual spurges, wild buckwheat, lambsquarters, Russian thistle, velvetleaf, morninnglory, waterhemp
- Glyphosate Resistant Weeds

Glyphosate Resistant weeds?

Annual ryegrass:	1996 - Australia, California, South America,S. Africa
Goosegrass:	1997 - Malaysia
Horseweed/marestail:	2000 - East and SE US. probably in Kansas
Common Ragweed:	2004 - Missouri
Palmer Amaranth:	2005 - Georgia, Tennessee
Waterhemp:	2005 - Missouri
Johnsongrass:	2006 - Argentina
Giant Ragweed:	2006 - Ohio, Indiana
Lambsquarters?	



None 1 pt 1 qt 2 qt 1 gal 2 gal

Kevin Bradley, University of Missouri (Rate of 3# ae glyphosate/A)

Current Glyphosate Resistance Evaluations at KSU

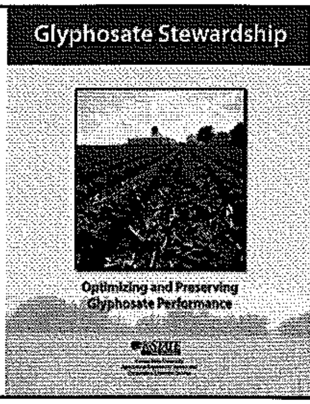
- Common Waterhemp (2 populations)
- Marestail (2 populations)
- Giant Ragweed (2 populations)

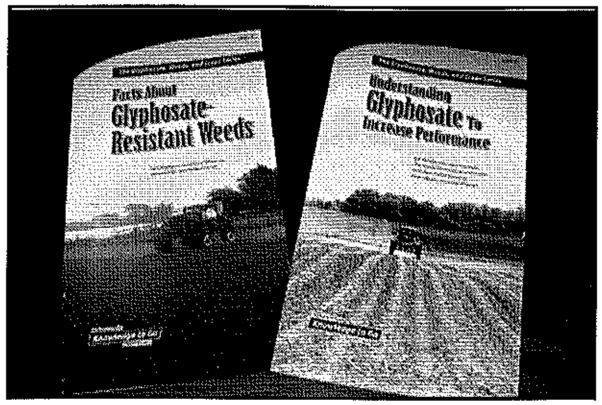
Best defense against developing glyphosate resistant weeds:

- Avoid continuous, exclusive use of glyphosate for weed control
  - Crop rotation, especially with non RR crops
  - Rotate and/or tankmix herbicides with different sites of action, within and across years
  - Include other control tactics (cultivation, prevention, crop competition, cultural practices)
  - "Use the proper rate at the proper time"

How does herbicide rate affect resistance development?

- Higher rates may enhance selection for single gene, highly resistant biotypes.
- Lower rates may select for multi-gene, low level rate creep or marginally controlled weeds.





Herbicide and Weed Information on Internet

- **KSU Weed Management:** **www.oznet.ksu.edu/weedmanagement/**
- **Pesticide labels, supplements, and MSDS sheets:** **www.cdms.net/**
- **Kansas Department of Agriculture:** **www.ksda.gov/default.aspx?tabid=1**
- **Weed Science Society of America:** **www.wssa.net/**
- **K-State Research & Extension:** **www.oznet.ksu.edu/**

K-STATE

Research and Extension

Dallas Peterson
Extension Weed Specialist
785-532-5776
dpeterso@ksu.edu

Sprayer Ownership: Is it for you?

Farmers from the Northwest Kansas Crop Residue Alliance

Managing Crops with Limited Irrigation

Alan Schlegel, Loyd Stone,
and Troy Dumler
Kansas State University

Justification

- Decreasing groundwater availability
  Declining water table
  Diminished well capacities.
- Increasing pumping costs
  Increased energy costs
  Lower well capacities.
- >90% of groundwater pumped for irrigation
  Corn most popular crop (>50% of irrigation).

Objectives

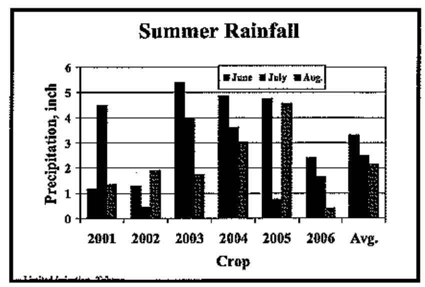
- Quantify crop yield/water use relationships.
- Demonstrate alternatives for efficient/profitable use of limited amounts of irrigation.
- Determine impact of crop selection on profitability with limited irrigation.

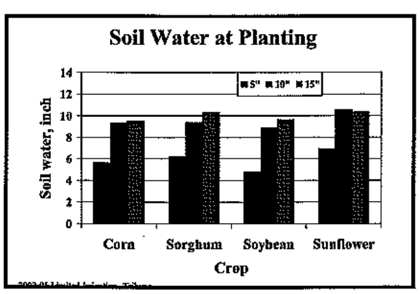
General Procedures

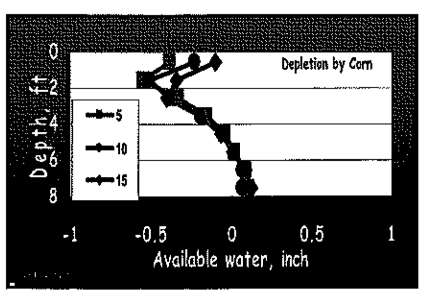
- No-till for all crops
- Sprinkler irrigation at most critical time (maximum of 1.5 in/wk)
- Soil water and crop measurements
- Machine harvest
- Economic analysis

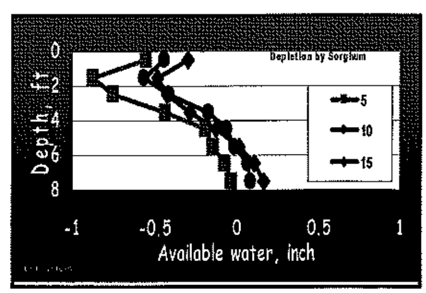
Limited Irrigation of Summer Crops

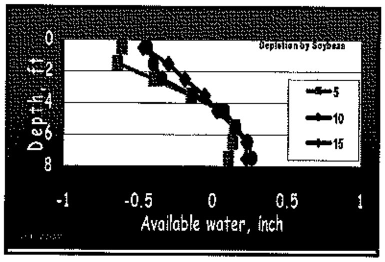
- Irrigation amounts
  5"
  10"
  15"
- Crops
  Corn
  Sunflower
  Grain sorghum
  Soybean

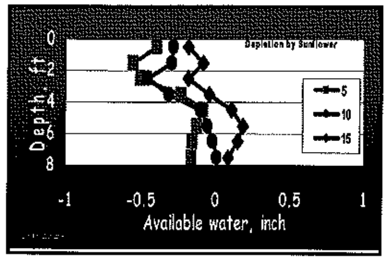


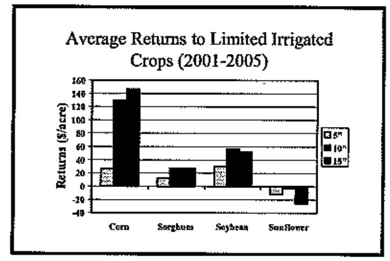












Grain Yield with Limited Irrigation 2006

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
Inches	------- bu/acre		---------	lb/acre
5	78	107	25	2340
10	145	109	40	3000
15	223	123	49	3160

Original hybrids and population

Grain Yield with Limited Irrigation 2001-2005

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
Inches	------- bu/acre		---------	lb/acre
5	114	93	30	1550
10	174	114	38	1880
15	191	125	42	1820

Seeding Rates with Limited Irrigation 2005-2006

Seeding rate	Corn	Sorghum	Soybean	Sunflower
	------- 1000 seeds/acre		-------	
Original	30	80	150	23.5
Alternate	24	100*	180	27.3

*Sorghum changed hybrids

Grain Yield with Limited Irrigation 2005

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
Inches	------- bu/acre		---------	lb/acre
5	138 (131)	80 (92)	23 (25)	1880 (1673)
10	194 (194)	76 (106)	23 (27)	1893 (1620)
15	211 (207)	86 (126)	28 (28)	1583 (1643)

Yields in parenthesis are at 20% different seeding rate

Grain Yield with Limited Irrigation 2006

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
Inches	------- bu/acre		---------	lb/acre
5	78 (107)	107 (90)	25 (21)	2340 (2010)
10	145 (182)	109 (136)	40 (41)	3000 (3020)
15	223 (211)	123 (165)	49 (48)	3160 (3010)

Yields in parenthesis are at 20% different seeding rate

Crop Rotations with Limited Irrigation

- **Corn-corn (10")**
- **Corn – Wheat (15"-5")**
- **Corn – Wheat – Grain sorghum (15"-5"-10")**
- **Corn – Wheat – Grain sorghum – Soybean (15"-5"-10"-10")**

Yields of Limited Irrigated Crops in Rotation (2006)

Rotation	Wheat	Corn	Sorghum	Soybean
Continuous corn	--	151	--	--
Corn-wheat	59	190	--	--
Corn-wheat-sorghum	61	197	162	--
Corn-wheat-sorghum-soybean	64	209	162	46

All rotations were limited to 10" of irrigation, except corn after wheat, which received 15" and wheat which received 5".

Yields of Limited Irrigated Crops in Rotation (2003-2005)

Rotation	Wheat	Corn	Sorghum	Soybean
Continuous corn	--	170	--	--
Corn-wheat	33	213	--	--
Corn-wheat-sorghum	33	211	125	--
Corn-wheat-sorghum-soybean	34	213	129	45

All rotations were limited to 10" of irrigation, except corn after wheat, which received 15" and wheat which received 5".

Yields of Limited Irrigated Crops in Rotation (2006)

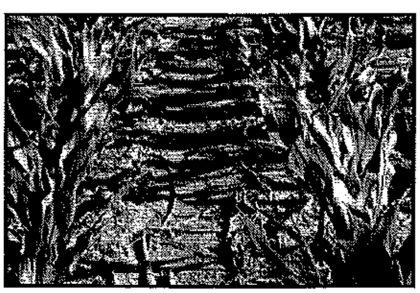
Rotation	Wheat	Corn	Sorghum	Soybean
Continuous corn	--	151(170)	--	--
Corn-wheat	59 (33)	190 (213)	--	--
Corn-wheat-sorghum	61 (33)	197 (211)	162 (125)	--
Corn-wheat-sorghum-soybean	64 (34)	209 (213)	162 (129)	46 (45)

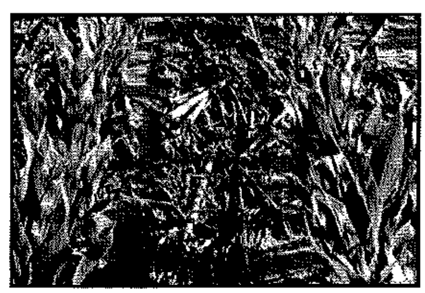
Values in parenthesis are 2003-2005 average yields.

Tillage Impact on Corn Production

Treatments

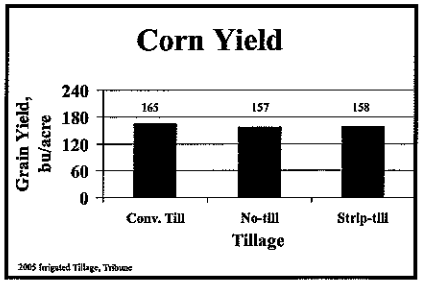
- **Tillage systems:**
  Conventional, strip, and no-till
- **Sprinkler irrigation capacities:**
  0.16 and 0.24 inch/day
- **N rates:**
  160 and 240 lb N/acre

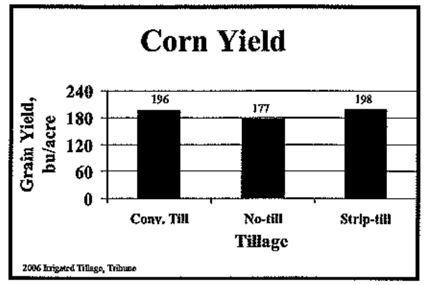


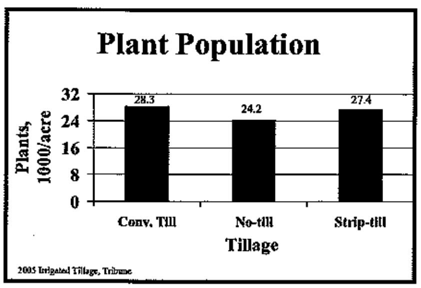


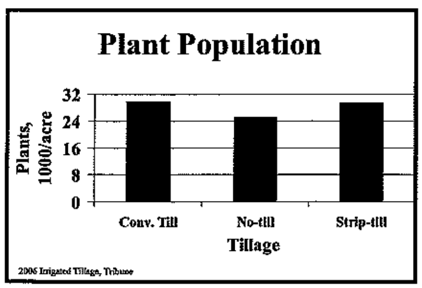
Tillage and Irrigation Capacity 2006

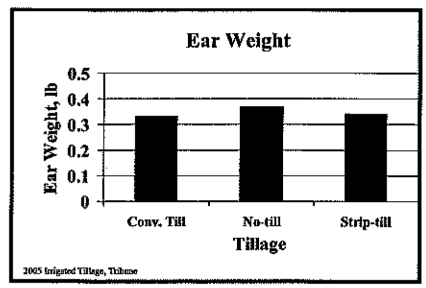
	Irrigation	
Tillage	Low	High
	---------- bu/acre ----------	
Conv.	172	221
No-till	177	193
Strip-till	194	210

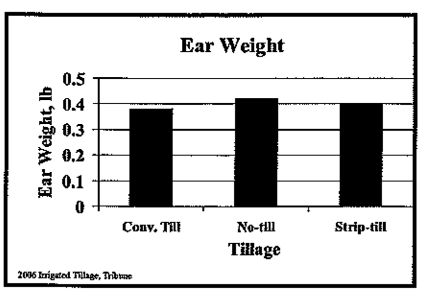


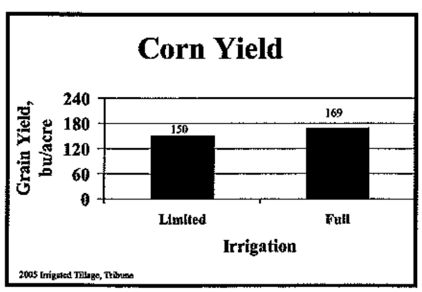


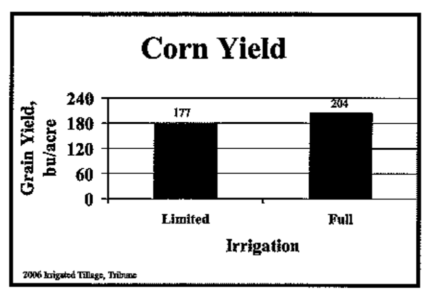


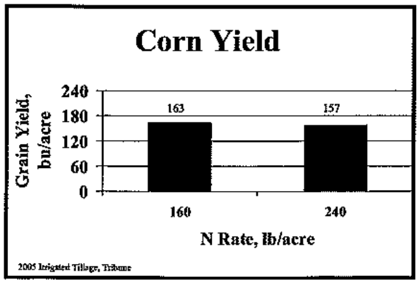


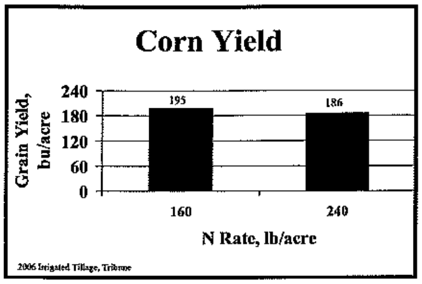












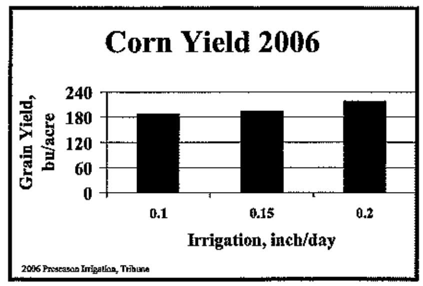
Preseason Irrigation, Irrigation Capacity, and Seeding Rate on Corn Production

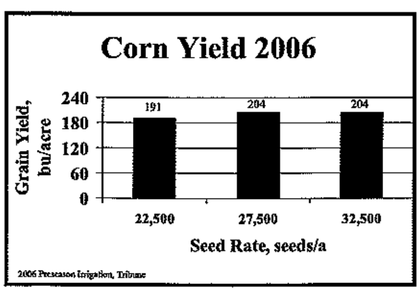
Treatments

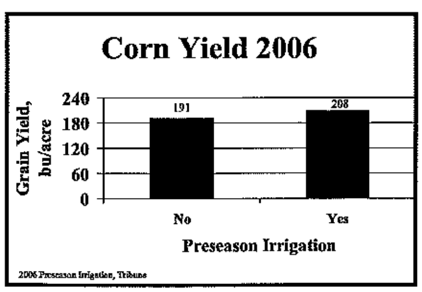
- Preseason Irrigation:
  With and without (~3 inch)
- Sprinkler irrigation capacities:
  0.10, 0.15, and 0.20 inch/day
- Seeding rates:
  22.5, 27.5, and 32.5 thousand/a

Pre-season Irrigation 2006

Irrigation amount	Seedrate	Pre-season No	Pre-season Yes
inch/day	seeds/a	--- bu/acre ---	
0.10	22,500	175	185
	27,500	174	200
	32,500	175	211
0.15	22,500	181	200
	27,500	194	206
	32,500	176	207
0.20	22,500	201	201
	27,500	219	228
	32,500	223	233







These projects were supported by:

- Ogallala Aquifer Initiative
- Kansas Corn, Grain Sorghum, and Soybean Commissions
- Western KS Groundwater Management District #1
- Kansas Fertilizer Research Fund

Ogallala Aquifer - Where are we going?[1]

Where have we been?

The development of the Kansas portion of Ogallala Aquifer follows the model of many human endeavors; recognition of the value of a resource then exploitation of the resource. This model has resulted successful in development of many resources and has aided human progress but often has unintended or disregarded environmental and social consequences since long term long term planning is not employed. Even with long term planning, outcomes are often flawed as new technology or unexpected demand changes results in great deviations from the original baseline assumptions. The development and use of resources also often result in a classic conflict between beneficial and economic use of a resource by individuals versus the benefit or economic interest of the state (society at large) and an uncertain future value. This paper will certainly not resolve the water issues with regards to the irrigation use of the Ogallala aquifer but will review how the Kansas irrigated agricultural sector has used the aquifer and some of the adjustments in use that may occur.

Irrigation Trends

Although early irrigation development (Figure 1) was generally associated with use of surface water and canal systems, early attempts to use underground water resources began in the early 1900's but in limited amounts and mixed results. Large scale development of the Ogallala commenced following World War II as policy and technology combined to provide both the will and ability to utilize the resource. The 1945 Water Appropriation Act was a significant document that dedicated all Kansas water to the use of the people of Kansas, subject to state control and regulation. The major purpose of the act is to protect the people's right to use water and to protect the states supplies of ground and surface water for the future. The Act, while sounding restrictive, was actually a document that encouraged development of water resources. Improvements in drilling and pumping technology allowed individuals access to the Ogallala aquifer. Development of land for irrigation rapidly increased and was aided by new irrigation system technology, such as the center pivot irrigation system. 1940's and 1950's irrigation development was predominately surface irrigation, largely gated pipe flood systems. The center pivot, invented in 1958, allowed expansion of irrigation into land that was either too sandy or too undulating for surface irrigation development. In 1970, less than 500,000 of the 2 million irrigation acres were center pivot irrigated. Today, about 85 percent of the 3 million irrigated acres are center pivot irrigated (Figure 2).

In retrospect, the state of Kansas and irrigators, operating from the viewpoint of a vast and limitless untapped Ogallala water supply, were overly optimistic about the extent of the supply. Although by the 1960's, there were warning signs and recognition of supply limitations which eventually resulted in legislative and water administrative policy changes and actions.

By the 1970's, that transition from a water development mentality to a mentality of preserving or conserving the Ogallala through improved irrigation systems and management. However, while

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these efforts certainly have aided reducing the amount of water withdrawn, maintaining productivity, and improving the beneficial use or water use efficiency of the pumped water, the amount of water withdraw still exceeds the change level as evidenced by continuing regional water level declines.

As Ogallala water levels continue to decline well productivity or capacity decreases, eventually to the point that irrigation is abandoned. This has already occurred in west central Kansas and other localized areas, especially land that was located along the historical fringes of the Ogallala. The irrigator response to declining water levels is a site specific response depending on the operating costs and operational needs. Certainly many individuals have had to make dramatic changes, including irrigation abandonment. However management strategy changes prior to abandonment may included change in irrigation system type and/or nozzle package, change in crop, change in crop mix, change in yield goal and change in other cultural practices associated limited irrigation. These changes in irrigation strategies are not readily apparent using the irrigation trend data as a center pivot with full irrigation capacity is reported in the same manner as a center pivot with limited irrigation capacity. Crops changes are also subtle. For example, a limited irrigated crop option for fully irrigated corn is limited irrigated corn. Crop trends are shown in Figure 3 for the five the major irrigated crops, which shows that corn is still the most commonly irrigated crop. Two crop options not shown on the chart are cotton, which is currently limited to the southern border area of Kansas, and sunflower, which is grown throughout western Kansas but is currently concentrated in northwest Kansas. Another interesting development is a pocket of potato and onion production in sandy soils along the Ark River corridor. Figure 4 is a chart of the statewide average yield of irrigated corn, which indicates an increasing yield trend of about 2.6 bushels per acre since 1974; a remarkable achievement in light of the drought conditions during the 2000's. While the 1990's, in general, were wetter then normal and the 2000's have been drier then normal, but Figure 5 shows the average irrigated water application depth per acre and the total irrigation pumping did not increase in proportion to the crop water needs relative to the climatic conditions. This is also evidence of the effect of declining water levels on irrigation capacity.

Where are we going?

Better irrigation efficiency, improved irrigation management practices, improved cultural practices and continuing development of improved crop genetics has maintained or improved productivity and economic returns but in spite of these improvements, the Ogallala aquifer continues to decline. Because of variability of the aquifer systems, some areas are completely depleted while other areas have saturated water thickness sufficient for hundreds of years of use at current withdrawal rates. There are some studies that estimate a 70 to 90 percent reduction in water withdrawal is needed to reach the sustainable aquifer withdrawal rate. This is unlikely that such high reductions in pumping and maintenance of the current irrigated acreage base is possible since perfect irrigation efficiency and management practices would only be able to reduce withdrawals by a fraction of amount needed to stop water level declines.

While reduction in water withdrawal is inevitable as supplies are depleted, changing long-term policy to affect current use rates quickly collide with short-term economic realities of individuals with irrigation investments and income needs. Physical depletion of groundwater supplies by declining water levels, in addition to changes in production costs and crop prices, has required irrigators to adjust their adjustment strategies including reduction of irrigated acreage, changes in crops and changes in crop mix. However, the unfortunate reality is that there are few widespread higher water use values options for individuals. Current alternatives include transferring of water rights to industrial uses. Recent options include power generation and other agriculturally based industry, such as cattle feeding, meat packing and dairies. However, remember transferring of a water right from one type of use to another would not alleviate the decline unless there is an reduction in the total amount of water used.

The ideal scenario would be a reduction in water withdrawals to the sustainable level with the remaining withdrawal being used for higher values uses that offset the economic impact of the decreased withdrawal. Unfortunately, no such higher use option seems looming on the horizon. But should some higher use value option be identified and developed, the shifting of a broad based irrigated agricultural system, spread across many individuals and locations, to localized points of use is problematic.

Are there possibilities ahead?

My crystal ball is pretty dim. Early in my career, I attended several water meetings where preliminary results of the High Plains Aquifer study were presented and predicted the economic life of the Ogallala to be about 20 years (Final report: Ogallala Aquifer Study in Kansas, Kansas Water Office 1982). I thought I had made a terrible mistake accepting the position as the NW K-State Irrigation Engineer. More than twenty years have past, and irrigation is still an important industry, still with long term sustainability issues, and still with some individuals facing tough economic circumstances. What does loom on the horizon is the state and federal renewable energy emphasis of recent vintage that I feel has great positive potential for Kansas agriculture but, of course, can have some negative unpredicted and unintended impacts. How much impact for the Ogallala region is difficult to predict but certainly short term economic benefits from the grain producers viewpoint have occurred due to stronger crop prices. Since the currently mentioned supply sources for ethanol and other biofuels production require land based production, the farm economy should benefit and, hopefully, a net positive gain in total energy availability is accomplished. Wind energy farms could also have a positive impact but due to its variable nature, possibly wind energy tied to hydrogen production (using a portion of the current irrigation water base) could convert a variable energy source into an on-demand energy source that may be more marketable. A long ago model of production called for the harvesting of solar energy from a portion of the field, capture and transfer of precipitation from the solar portion to the non-solar portion of the field for crop production. The feasibility of that type of food, fiber and energy production system does not seem so fetched today - just throw in a ring of wind turbines around the perimeter so good measure.

As a Kansas State Research and Extension Irrigation Engineer, my primary responsibility has been to help individuals make decisions about the use of the resources that they have at their disposal, usually from an economic viewpoint, although larger and long-term social and environmental and other non-economic considerations are often discussed. I can only predict that whether forced by physical constraints (depletion), economic constraints (not profitable to continue current production practices) or institutional constraints (change in water law/policy) the future will be different then the past except for the ability and creativity of the current residents of the Ogallala region in Kansas to adapt.

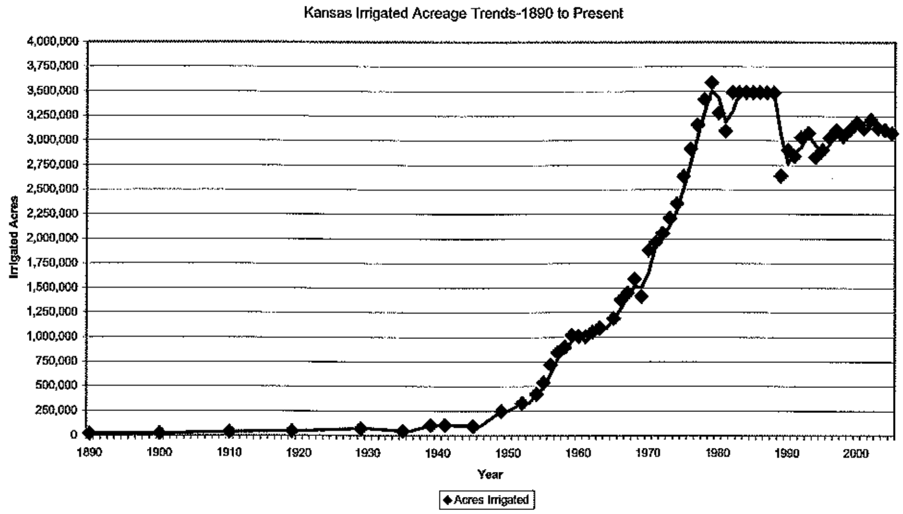


Figure 1. Kansas Irrigated Acreage Trends – 1890 to Present

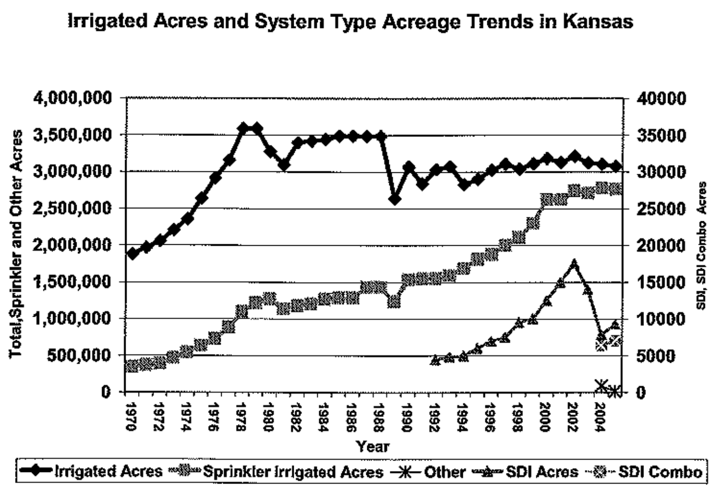


Figure 2. Irrigated Acres and System Type Acreage Trends in Kansas

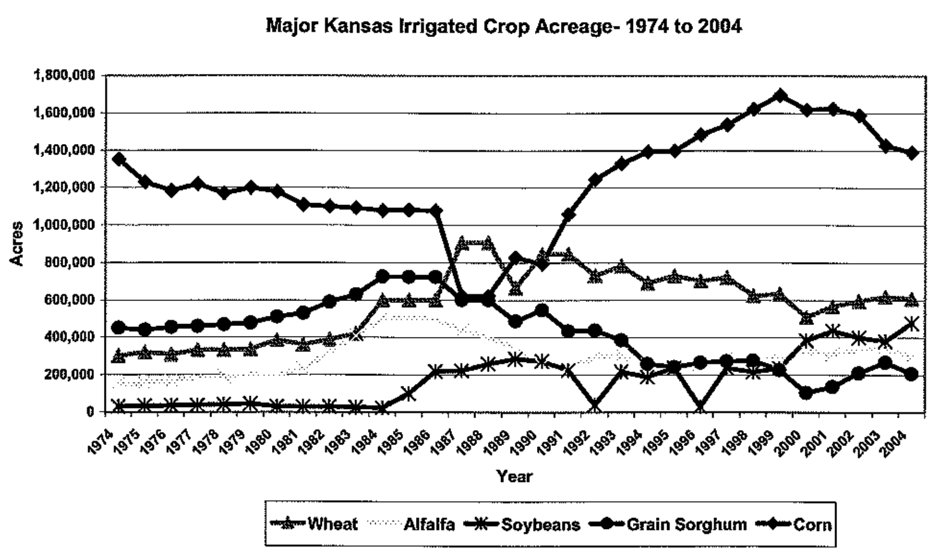


Figure 3. Major Kansas Irrigated Crop Acreage – 1974 to 2004

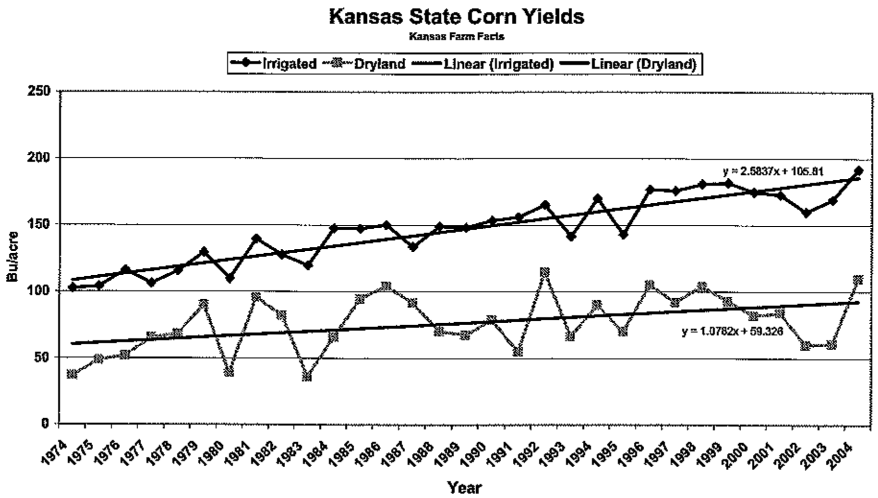


Figure 4. Kansas State Corn Yield Trends

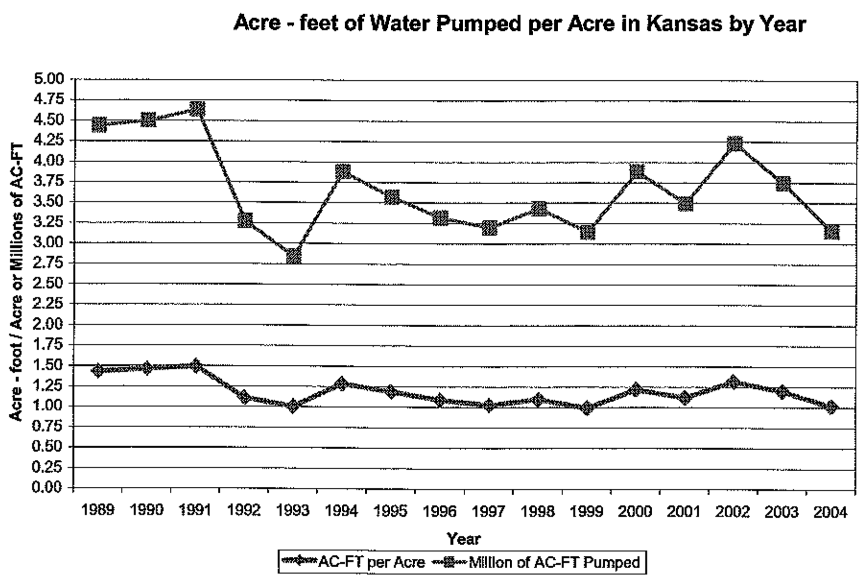


Figure 5. Acre-feet of Water Pumped per Acre in Kansas by Year

Dryland Soybean Production

Farmers from the Northwest Kansas Crop Residue Alliance

2007 Cover Your Acres Conference

No-Till Wheat Production in County Variety Trials

Brian Olson, Extension Agronomist - Northwest Kansas
Jeanne Falk, Multi-county Crops & Soils Specialist
Daniel O'Brien, Extension Agricultural Economist - Northwest Kansas

The majority of northwest Kansas wheat producers use conventional-tillage to prepare their ground for wheat planting. Typically, this does not leave enough crop residue on the soil surface for adequate soil conservation prior to wheat planting. This was evident in three events in recent history. On Dec. 18, 2000, state highways in many western Kansas counties were closed because soil blowing off recently planted wheat fields had reduced visibility, causing unsafe driving conditions. Street lights came on at mid-afternoon in Colby and many other towns due to the dust-darkened skies. In contrast, a nearby no-till wheat field had little erosion and retained snow to the depth of milo stubble left from the previous crop. Additionally, the no-till field had enough moisture for planting two to three weeks earlier than surrounding conventional tillage fields. On May 29, 2004, some producers had started tilling and preparing their fields for winter wheat planting this fall when a dust storm blew through the area causing similar conditions as described above.

Rainfall on Sept. 17 and 18, 2001 came rapidly, resulting in major erosion of wheat fields. Roadside ditches and county streams were filled with topsoil while many gullies were formed or deepened. Tillage to repair gullies and replanting was necessary in most instances. In contrast, a nearby no-till wheat field suffered no erosion, achieved a complete stand and total ground cover. Improved soil and moisture conservation provide cleaner air and water for everyone.

Fallow treatment herbicide costs have decreased dramatically in the last three years, due primarily to the expiration of the "Round-Up" patent. To illustrate, per unit costs of Round-Up© in K-State crop planning budgets have declined from $44.75 per gallon in 1998 to $37.60-$37.80 in 1999-2000 to $22.00 per gallon 2003 to $15.00 per gallon in 2006 for a generic glyphosate. In addition, many producers are reducing herbicide costs through improved sprayer technology and timely applications. Tight profit margins have plagued wheat and other dryland crop enterprises in recent years. Equipment, fuel and labor cost continue to increase. The combination of these economic forces are motivating producers to consider more efficient uses of cropland. No-till wheat production is perhaps the most effective practice available to meet these constraints.

Planter technology has improved in recent years such that acceptable stands can be achieved in most planting conditions with a shower following planting. Most manufacturers offer a no-till drill, but there is considerable variation in equipment configuration and confusion among producers as to which configuration they might need. The cost of such equipment is often a barrier to adoption of the practice.

An increasing number of producers are intensifying rotations by eliminating fallow periods after summer crops and planting winter, or sometimes spring wheat after the fall harvest. The success of this practice is dependant on moisture conservation and residue management. No-till planting should be the critical success factor.

On the topic of yield response, a ten year study at Tribune, KS, showed an eight bu/a advantage for no-till wheat production compared to conventional tillage in a wheat, sorghum, fallow rotation. If costs can be maintained or decreased while adopting the technology, it would increase net profit. Wheat research done at the USDA-ARS unit at Akron, CO, has shown over four bu/a yield increase for each additional inch of moisture.

OBJECTIVES OF THE STUDY

1) Add no-till wheat variety plots to existing county wheat variety plots in northwest Kansas to demonstrate the feasibility of no-till wheat production and increase educational opportunities of existing county extension events.

2) Gain insight and better define no-till management changes necessary as annual precipitation decreases from 24 inches in north central Kansas to 16 inches in western Kansas, especially as it relates to frequency of wheat in the rotation.

RESULTS OF THE STUDY

During the past three years, weather has been highly variable. In 2004, weather limited the number of sites with useable information. In 2005, fourteen sites were initially planted, with nine sites harvested. In 2006, eleven sites were planted with seven sites harvested. The weather variability ranged from extremely dry conditions to late spring freezes which caused sites to be abandoned. All sites in all years had Jagalene, Jagger, Cutter, Stanton, 2137, and T-81 planted at 85 lbs/A across both tillage systems in side-by-side comparisons. **Most of the no-till was on sites that were in their third year of no-till. Because of this, the results should be viewed as what will typically happen on area fields when farmers are transitioning to a complete no-till system.** In addition, weather variability across the sites and years was extreme during the time of the study. However, there were three main points which could be gleaned from the data.

1) Yield Results

Data from 2005 and 2006 was analyzed while the limited data from 2004 was not used in the final analysis. To account for some of the year to year variability, the data was normalized by the average yield across all sites for a particular year. A variable indicating whether the yield potential of a site was either high or low was assigned to each field in each year (high potential - above 35 bu/A, low potential - below 35 bu/A). The variable was assigned based upon the average yield across varieties and tillage systems for the site. The data was then analyzed by SAS (Statistical Analysis Systems).

From the analysis, a tillage by yield potential interaction was apparent (Table 1). Many factors could affect yield potential, but the one major factor was the dry conditions.

When the yield potential of the site was higher than 35 bu/A, the yield potential for the two tillage systems was similar. This is in contrast to the above research from Tribune and Akron that indicated a benefit to no-till. However, the benefit to no-till took time to accumulate at Tribune and Akron and was not apparent in the initial years of the rotation.

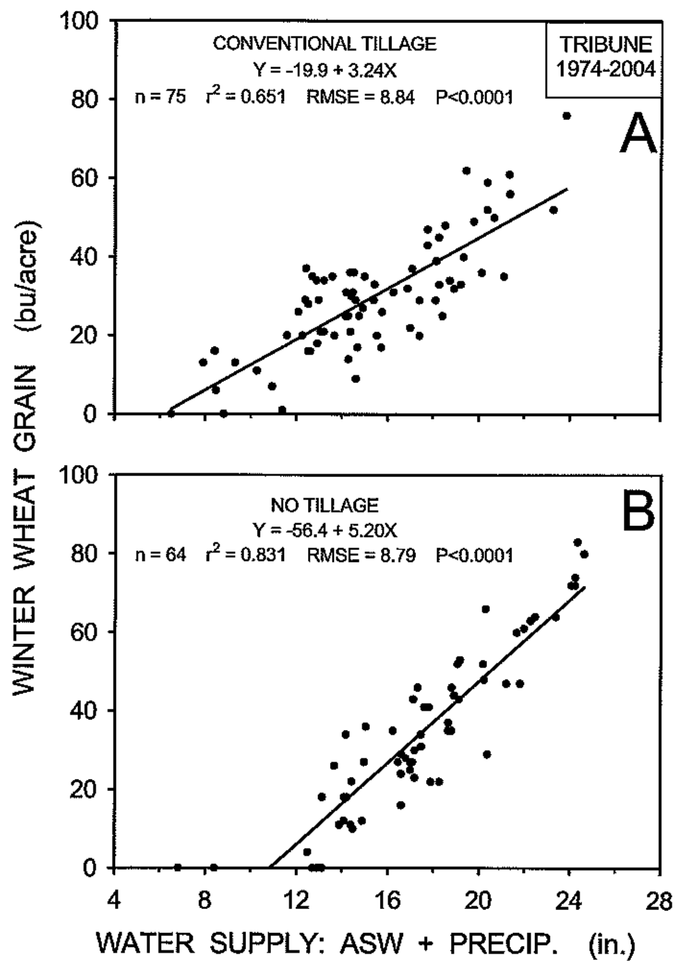
When looking through the data from the county comparisons, there appeared to be a major benefit to injecting fertilizer over broadcasting in no-till. Due to the management system of the farmers at the sites, there was not ample sites of the injected versus broadcast comparison to provide a statistical analysis of that variable. Therefore, the two tillage systems yielded similarly in high yielding environments when fertilizer was either broadcast or injected.

Table 1. Yield as affected by yield potential and tillage

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

When the yield potential of a site was below 35 bu/A, the perceived benefits of no-till did not translate into higher yields. One potential reason for this was that fields transitioning into no-till are typically hard when conditions are dry. Over time after the third year, the ground will become more mellow as more residue is accumulated and more macro-pores are developed. However, during that initial rotation back to wheat in a wheat-summer crop-fallow rotation, the ground will likely be difficult to work with. Therefore, the hard no-till ground may have limited root growth substantially compared with conventional-till, and thus the conventional-till yielded more in the drier environment.

Fig. 1 - Wheat yield potential as affected by tillage and water supply.



This phenomena of lower yields from no-till when the potential yield is low was also observed in research recently summarized from the Southwest Research and

Extension Center - Tribune station (Fig. 1). When the water supply (available soil water at planting + precipitation) was low, conventional-till yielded more than no-till. For example at 10 inches of water, conventional-till yielded 10 bu/A while there was no yield for no-till. When there was 18 inches of water supply, the two tillage systems had similar yields around 35 bu/A. When there was 24 inches of water supply, no-till had an average yield of 70 bu/A, while conventional-till yielded 60 bu/A.

When evaluating the profitability of the two systems, the costs for no-till to conventional-till have changed over the years. For this comparison, the average 2006 custom rates for the state of Kansas from the National Ag Statistics Service were used. The number of spraying and tillage operations used to control weeds before wheat planting were summarized from informal discussion with area farmers.

The number of burndown applications versus tillage operations from May until wheat planting were summarized in Table 2 when farmers where in a wheat-summer crop-fallow rotation. Weather during the summer impacted the number of operations.

Table 2. Chemical or mechanical weed control operations from May until September during a dry or wet summer.

Tillage	Dry Summer	Wet Summer
No-till (chemical)	3	4
Conventional-till (mechanical)	5	7

When evaluating the costs of the two systems, the following assumptions were made. Chemical control was achieved by applying 32 oz/A of a generic 4 lbs ai/gal glyphosate with 8 oz/A of 2,4-D, and 17 lbs/100 gal ammonium sulfate per spray operation using a ground rig. For the mechanical control, all tillage operations consisted of a field cultivation, except for the final operation before planting in which a disk was used. The total chemical and application costs per spraying operation was $9.32/A . Field cultivation cost $7.37/A and disking cost $7.79/A. At planting, $11.77/A was the cost associated with planting wheat no-till, and $8.52/A for planting wheat conventional-till. Custom harvest costs of $15.78/A as a base charge, with an additional $0.149/bu for yields over 21 bu/A were assumed. Hauling costs of $0.145/bu for hauls under 14 miles were also assumed. The cash price of wheat used in this analysis was $3.50/bu.

In Table 3, the net cash income returns under no-till and conventional-till under various scenarios are given. In these calculations, revenues from cash sales of wheat are included, but not from government farm program payments or any type of crop insurance coverage. Costs covered include those for field operations, herbicides, custom harvest and hauling. The net returns indicated here would be used to then pay for all other cost of production not identified above, including land. The bu/A used for each tillage by yield potential came from Table 1. Due to the decreased yields observed in no-till in a low yielding environment, there was more money to pay for fixed costs in conventional-till. However, when the yield potential was above 35 bu/A, there was more money to pay for fixed costs in no-till.

Table 3. Cash returns analysis of no-till and conventional-till.

	Below 35 bu/A		Above 35 bu/A	
Tillage	Dry summer	Wet Summer	Dry summer	Wet Summer
No-till	$3.20	($6.12)	$126.19	$116.87
Conventional-till	$17.22	$2.48	$115.64	$100.90

2) Varieties

When results were combined across years, there was no significant tillage by variety interaction. The varieties of Jagger, Jagalene, Cutter, T-81, 2137, and Stanton yielded similarly across tillage systems. Since the wheat performance tests at K-State are done on conventional-tilled ground, the results from this study indicate a farmer can evaluate a variety from the Kansas Crop Performance Test for yield and other agronomic characteristics and not worry whether there will be a difference in yield if the variety is grown on no-till. There will still be some varieties which might be more preferable in some situations such as continuous no-till wheat due to their disease ratings. In this situation, the variety's rating for tan spot should influence what variety is chosen. However, the yield component of the varieties can be compared regardless of tillage system.

3) Seeding Rate

A seeding rate study was also included at all sites. Jagalene was planted at 68, 85, 102, and 120 lbs/A in both tillage systems. When looking at the data across 2005 and 2006, there was no difference in seeding rate for a particular tillage system or when across tillage systems. Yield was 48.5, 50.2, 50.2, 49.4 bu/A for 68, 85, 102, and 120 lbs/A, respectively. Therefore, there was no significant difference between seeding rates. For those farmers starting no-till, a higher seeding rate of 90 to 100 lbs/A is recommended. A higher seeding rate than what is typically used in conventional-till is recommended because surface residue may hinder stand establishment, and there was no disadvantage from using the higher seeding rate.

In summary, although the highly variable environment decreased the number of sites where data was collected, producers can use the findings of this study to aid in management decisions for their crop production system. The results from this study have been discussed at 2006 preplant wheat schools and in winter meetings like the Cover Your Acres Winter Conference, January 23 and 24, 2007 in Oberlin, Kansas.

Skip-row Corn

Presentation – Drew Lyon and Brian Olson

Research – A. Pavlista, D. Baltensperger, D. Lyon, R. Klein, G. Hergert, C. Shapiro, S. Knezevic, L. Nelson, S. Mason, A. Schlegel, M. Vigil, R. Elmore, B. Olson, R. Aiken

RATIONALE

MITIGATE LOW MOISTURE STRESS LATER IN SEASON DURING CRITICAL PERIOD FOR KERNEL FILL

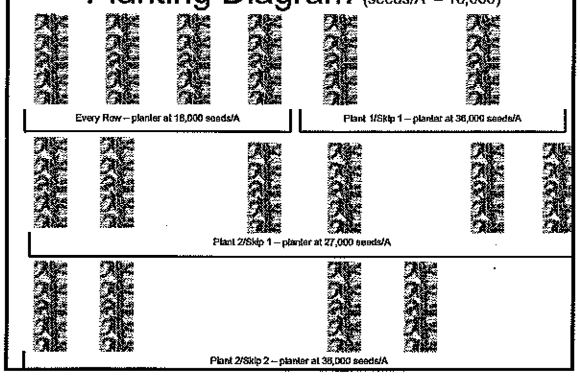
OBJECTIVE

WILL SKIP - ROW PATTERNS

INCREASE YIELD

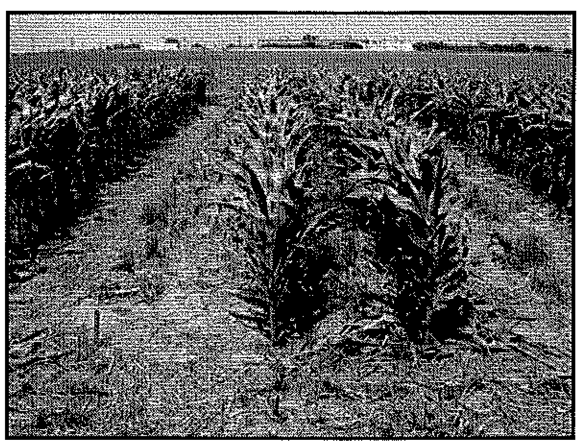
COMPARED TO CURRENT PRACTICES
?

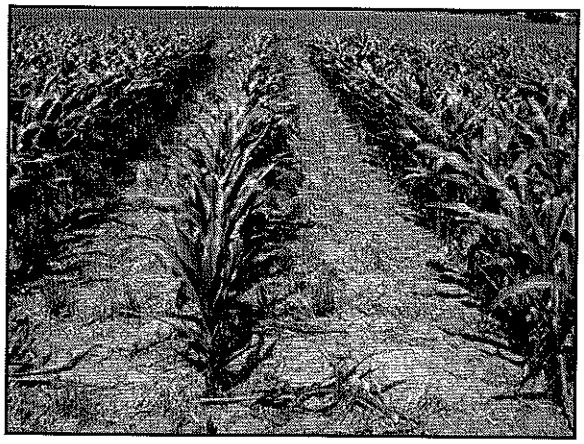
Planting Diagram (seeds/A – 18,000)



Possible reason why skip-row has the potential to work

- Changes the time of when moisture is used.
- Dry conditions
  - Plant space every row will use water as they are growing with little moisture available at reproduction
  - With skip-row corn, moisture becomes limiting earlier within the row when the plants are young. However, as they grow and extend their roots, there is a bank of moisture in the skipped row that allows the plant to continue through reproduction.

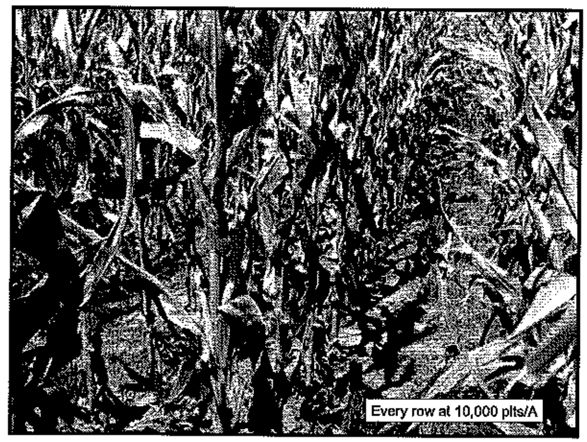




Colby - 2006

Row spacing	Target population (plts/A)	Test weight	Bu/A	Actual population (1,000 plts/A)
Every row	10,000	56.9	17.0	9.9
	15,000	55.1	3.7	16.4
	20,000	55.9	2.1	21.1
Plant 1/ skip 1	10,000	57.4	22.3	10.1
	15,000	57.5	11.7	14.2
	20,000	56.5	9.7	19.4
Plant 2/ skip 1	10,000	57.4	22.4	10.6
	15,000	56.8	7.4	14.7
	20,000	56.5	3.7	19.1
Plant 2/ skip 2	10,000	58.4	28.5	9.8
	15,000	56.8	19.0	14.8
	20,000	57.4	10.5	18.7
CV, %		1.5	30.1	12.0

Plant 2/skip 2 at 10,000 plts/A



Every row at 10,000 plts/A

Tribune - 2004

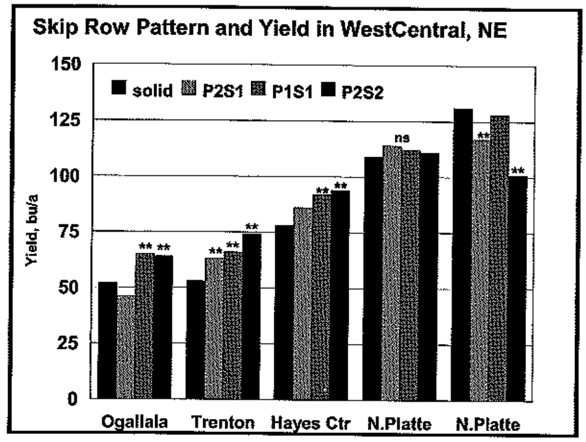
Row spacing	Target population (plts/A)	Test weight	Moisture %	Bu/A	Actual population (1,000 plts/A)
Every row	10,000	54.8	21.5	72	9.5
	15,000	55.9	20.6	116	15.0
	20,000	56.5	19.1	117	18.5
Plant 1/ skip 1	10,000	54.9	22.0	75	9.4
	15,000	56.7	20.1	97	14.5
	20,000	56.6	19.1	118	18.8
Plant 2/ skip 1	10,000	56.1	20.1	64	9.1
	15,000	55.8	20.1	98	14.5
	20,000	56.7	19.9	105	19.5
Plant 2/ skip 2	10,000	55.5	20.6	68	9.3
	15,000	55.9	20.3	86	13.5
	20,000	56.8	19.3	90	19.6
CV, %		2.3	6.7	12.7	7.8

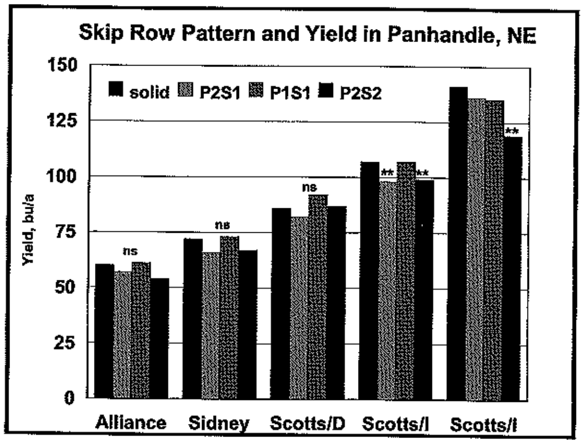
All treatments had a 80 lb/A UAN dribbled on February 26 and 4 gal/A 10-34-0 dribbled beside row on May 9. Corn was planted May 9 using Pioneer 33B25RR no-till into wheat stubble

Multi-sites

Trial Locations by Year, 21 Trials

2004:	2005:	Trial Populations
Scottsbluff *	Alliance *	* 10,000 pl/a
Hayes Center *	Scottsbluff (2x) *	15,000 pl/a
North Platte *	Sidney *	20,000 pl/a
Akron, CO ***	Ogallala *	
Tribune, KS *	North Platte *	** 15,000 pl/a
Clay Center **	Trenton *	22,500 pl/a
Lincoln **	Akron, CO ***	30,000 pl/a
Mead **	Tribune, KS *	
Concord **	Clay Center **	*** 8,000 pl/a
	Mead **	12,000 pl/a
	Concord **	16,000 pl/a





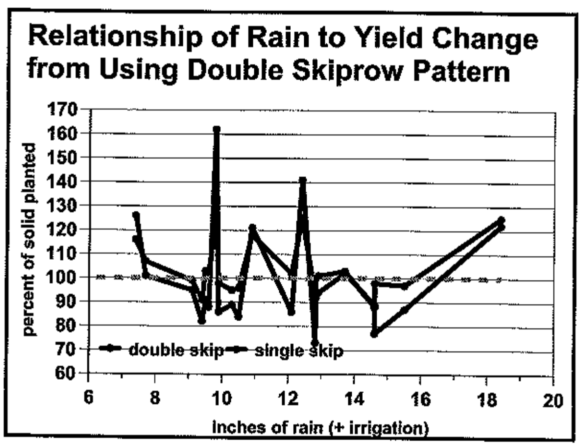
Skip Row Effect on Yield, 21 Trials

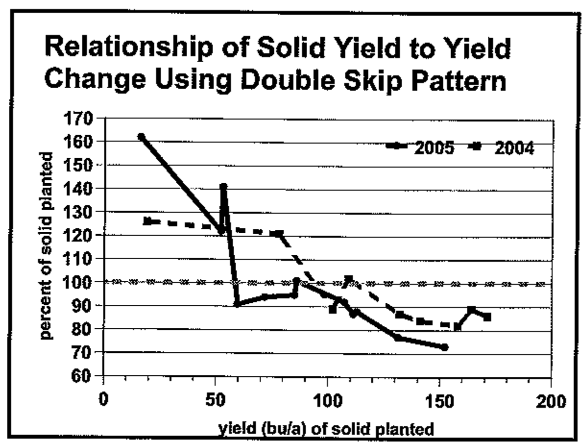
(5) 2004: Hayes Center, Akron (CO)
2005: Ogallala, Trenton, Akron (CO)

(8) 2004: Clay Center, Lincoln, North Platte
2005: Alliance, Clay Center, Scottsbluff/dry. Sidney, Tribune (KS)

(8) 2004: Scottsbluff/irrig., Tribune (KS), Mead, Concord
2005: Scottsbluff/irrig., North Platte, Mead, Concord

FACTORS: Tillage ? Residue ? Rain ? Low Yield ?



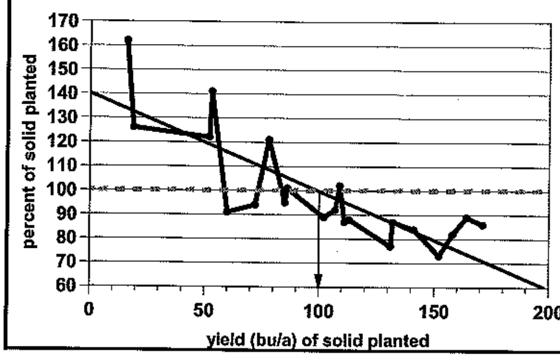


CONCLUSION

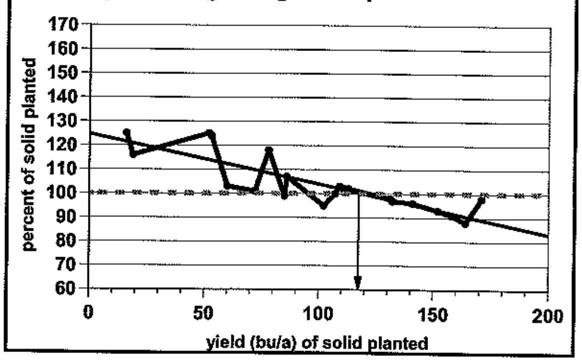
SINGLE - SKIP (1+1)
AND
DOUBLE - SKIP (2+2)

CAN HELP & CAN HURT

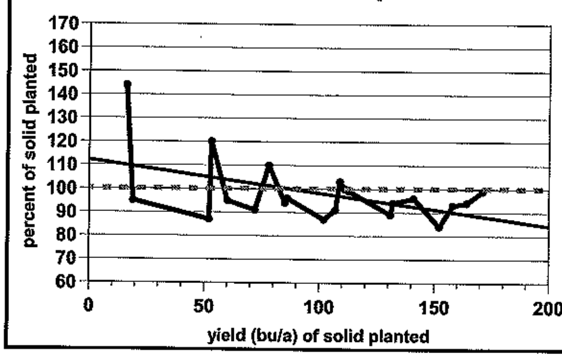
Relationship of Solid Yield to Yield Change Using Double Skip Pattern



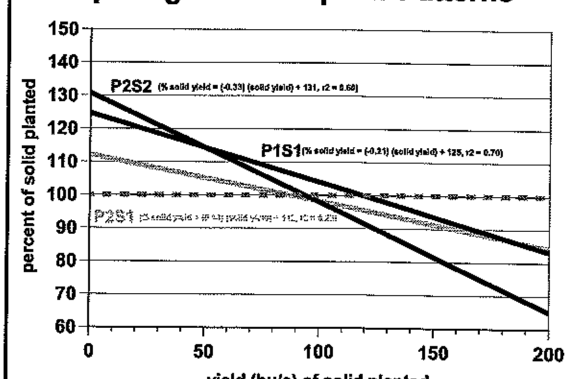
Relationship of Solid Yield to Yield Change Using Single Skip Pattern



Relationship of Solid Yield to Yield Change Using a Third Skiprow



Comparing Three Skiprow Patterns



RECOMMENDATION:

When Field History & Prediction is that Yield will be LESS than 90 bu /a Use Single or Double Skip Rows.

If Yield is Expected to be Higher, Do NOT Use Skip Rows as Yields Likely Will be Reduced.

Chloride, Sulfur, and Controlled-release Urea in Crops

Dale Leikam, K-State Soil Nutrient Specialist

Chloride

Since the early 1980's, considerable research with chloride fertilization has been conducted in Kansas on wheat, corn and grain sorghum. Positive yield responses have been noted on these crops. To date chloride fertilization on other crops has been limited.

Wheat. Chloride research on wheat in Kansas has been ongoing for 20 years. Early work clearly showed that chloride fertilization not only increased wheat grain yields on low Cl soils, but also suppressed the progression of leaf rust. Research has also clearly shown that differences exist among wheat varieties in terms of responsiveness to chloride fertilization.

The following information summarizes this chloride fertilization/wheat variety research. Averaged across all seven varieties, chloride fertilization increased grain yields by 8 bushels/acre. An 8 bushel per acre yield response to a micronutrient is quite impressive, but this was with outstanding wheat yields (70-90 bu/ac). Yield responses of this magnitude would not be expected at lower overall yields, though our research has shown a 7-10% yield increase on low Cl soils, regardless of yield level. Applying chloride consistently and dramatically increased leaf tissue Cl concentrations on all varieties.

Corn and Grain Sorghum Several site-years of chloride research on corn and grain sorghum are summarized below. Overall, results are very similar to wheat. All sites with low soil Cl levels (< 25-30 lb Cl/a) responded to Cl application. The nonresponsive sites had soil Cl levels of 40 lb Cl/a or higher. As with wheat, leaf tissue Cl concentrations of the check (no chloride added) treatments at responsive sites were generally 0.15% or lower.

Over the many years of work on Cl fertilization, we evaluated several chloride rates and sources. In most cases application of 10-20 lbs Cl/a was sufficient to achieve optimum response. We have evaluated ammonium chloride, magnesium chloride, calcium chloride, potassium chloride and even sodium chloride as sources. All chloride sources performed equally. Potassium chloride is the most readily available source. When potassium chloride is used as a Cl source, there is the possibility that the potassium could be the cause of any response. All of our research was conducted on sites with high soil potassium levels and we measured potassium concentrations in leaf tissue samples. We are convinced the responses noted are due to chloride, particularly since other Cl sources also provided yield increases. Other crops have not been evaluated.

Sulfur

Sulfur (S) is one of 17 elements essential for crop growth. Although sulfur is considered a secondary nutrient, it is often called the fourth major nutrient ranking just below nitrogen, phosphorus, and potassium in terms of how widespread deficient soils are.

Deficiencies of sulfur have increased in Kansas, most of North America and worldwide. The incidence of sulfur deficient soils has increased over the years and is likely due to one or more of the following:

- Much higher crop yields
- More intensive cropping systems (double cropping, less use of fallow, more use of crop residue) that results in greater sulfur removal
- Erosion of surface soil and organic matter over the years
- Less sulfur deposition from the atmosphere
- Continued use of fertilizers that contain little or no sulfur

Sulfur deficiency on growing crops is often mistaken for nitrogen deficiency. With sulfur deficiency, many crops become uniformly chlorotic. The pale yellow symptom of sulfur deficiency often appears first on the younger or uppermost leaves, while nitrogen deficiency initially appears on the older lower leaves. Deficiencies of sulfur are often difficult to identify because the paling in crop color is not always obvious. Crops lacking sulfur also may be stunted, thin-stemmed and spindly. In the case of cereal grains, maturity is delayed. On legume crops, nodulation may be reduced. In some crops, a reddish color may first appear on the underside of leaves and on stems.

Sulfur is usually present in relatively small amounts in soils and a majority is in organic forms. Sulfur deficient soils are often low in organic matter, coarse-textured, well-drained, and subject to leaching. In recent years, an increasing number of finer textured soils have shown sulfur deficiency, however. Much like nitrogen, sulfur tends to cycle in the soil environment.

Soil organic matter is an excellent source of sulfur. Since organic sulfur is not plant available, sulfate must be released from reserves of organic matter through microbial mineralization. Nitrogen and sulfur mirror each other closely in terms of the transformations and reactions that occur in the soil. Mineralization of sulfate from soil organic matter is controlled by organic matter levels, temperature, and moisture. Generally, environmental factors that favor plant growth enhance sulfur release from organic matter.

Sulfate ($SO4^{-2}$) is an anion (negatively charged ion) and as such is mobile in the soil though not as free moving as nitrate ($NO3^{-}$) or chloride (Cl^{-}). In well drained, coarse-textured soils, sulfate can be leached below the root zone especially in high rainfall areas or under irrigation. Supply of sulfate in soils can vary greatly from year to year, based on crop removal, environmental conditions, and the amount of sulfur deposition from the atmosphere.

The total sulfur concentration of soil varies widely from about 50 to 50,000 parts per million (ppm). As is the case with many other nutrients, however, total sulfur is not necessarily a good predictor of a soils ability to supply this nutrient. A soil test for available sulfate-sulfur has been developed. However, for proper interpretation of this test , soil organic matter, soil texture, the crop to be grown and the expected yield level also need to be factored in to accurately assess sulfur needs.

As with nitrate-N, soil samples should be collected from a deeper depth than for normal soil samples if the soil test is to be used. Since sulfate sulfur (SO4- S) is mobile, sampling to a 24-inch depth is suggested for best results. When sampling for routine analyses (pH, phosphorus, potassium) and organic matter and zinc a 0 to 6 inch and 6 to 24 inch sample is suggested.

Significant amounts of plant available sulfate-sulfur can be added to the soil via irrigation water. In Kansas, sulfur content of irrigation water varies, but in some cases enough sulfur could be added through irrigation to meet crop needs. The sulfur content of irrigation water should be determined by testing and factored into sulfur applications. However, it must be kept in mind that irrigation water must be applied before sulfur in irrigation water will help the crop. If it is well into the growing season before the first irrigation is made, the plant may be sulfur stressed early even though more than enough sulfur will eventually be applied during the growing season.

Timeliness of the sulfur additions also needs to be taken into account. An example is irrigated corn production on sandy soils.

There are many sulfur-containing fertilizer materials are available to agriculture.

Ammonium Sulfate. (21-0-0-24S) is one of the oldest sources of ammoniacal nitrogen, and is often blended with other dry. Ammonium sulfate is a good source of both nitrogen and sulfur, has low hygroscopicity, and is chemically stable. Its use may be undesirable on acidic soils, due to the acid-forming potential.

Ammonium Thiosulfate. (12-0-0-26S) is a clear liquid material with no appreciable vapor pressure containing 12 percent nitrogen and 26 percent sulfur. Ammonium thiosulfate is the most popular sulfur-containing product used in the fluid fertilizer industry, as it is compatible with nitrogen solutions and other complete (N-P-K) liquid. When ammonium thiosulfate is applied to the soil, it decomposes to form colloidal elemental sulfur and ammonium sulfate.

Potassium Magnesium Sulfate (0-0-22S-11Mg) is sometimes referred to as K-Mag, is marketed as a dry material that is 22 percent K2O, 22 percent sulfur, and 11 percent Mg. It is used in mixed fertilizers or sometimes applied alone to supply sulfur and magnesium on soils deficient in these two elements.

Elemental Sulfur (typically 90 to 95% S) is marketed by several manufacturers. These products are usually 90 percent or higher sulfur content with a small amount of binding material and/or bentonite clay to facilitate blending, application and soil reaction. Concern exists about availability of elemental sulfur during the year of application. Before it becomes available for plant uptake, elemental sulfur must first be oxidized by soil microorganisms to sulfate-S and this can be a slow process when surface applied.

Gypsum (analysis varies) is calcium sulfate and is commonly available in a hydrated form containing 18.6 percent sulfur. This material is generally applied in a dry form and is available in a granulated form that can be blended with other materials.

Potassium Thiosulfate (0-0-20-17S) is a relatively new product that is a clear liquid containing about 20 percent K2O and 17 percent sulfur. Potassium thiosulfate can be mixed with other liquid fertilizers and has potential for use in starter fertilizer mixes where both K and S are needed. This material should not be placed in direct seed contact. Potassium thiosulfate is not a commonly used product

Slow Release Nitrogen Fertilizers

Slow release N fertilizers have been around for a long time but their use has generally been limited to higher value crops since these products are significantly more expensive than conventional N fertilizers. Some slow release products, such as various urea aldehyde products, are N compounds of limited solubility that slowly release N as the product is decomposed by soil microbial and/or chemical processes. Over the years there have also been several products introduced that included coating urea with elemental sulfur – sulfur coated urea. After application to soil the sulfur coating was oxidized by soil microbes which allows water to dissolve the inner urea granule and become available for crop use and/or water infiltrated the coated product through imperfections/fractures in the coating and urea-N diffuses into the soil. As a result, the N in sulfur coated urea products becomes available to plants over time. The release characteristics of the sulfur coated products could be somewhat tailored to specific situations by managing the thickness of the sulfur coating. These products are most commonly found in the turf and golf industries.

The current controlled release N products employ several polymers for coating urea. Depending on the specific polymer used and the thickness of the coating, release characteristic can be better managed than with sulfur coatings. While production costs of these products have declined somewhat, polymer coated products are still relatively expensive for production agriculture. It is anticipated that these products will continue to become more price competitive in the future. For situations posing significant potential for N loss, polymer coated urea is another tool that is available to manage potential N loss from denitrification, leaching and volatilization.

Research across the U.S. has demonstrated the efficacy of the polymer coating and has sometimes resulted in greater N use efficiency and crop yields. Similarly, Kansas research has demonstrated the potential for these products. However, delayed/controlled release N fertilizers do not always result in increased yield. In much of Kansas, the potential for N loss is relatively small. It is likely that these products would perform similarly to conventional fertilizers. There are some situations in which these products might actually be inferior to our more conventional fertilizers. For dryland systems utilizing surface sidedress or topdress N application, N availability to crops is dependant on moving the N into the root zone for crop uptake. It is possible that coated materials might prevent /delay this movement until too late in the development of the crop.

Table 1. Chloride fertilization on wheat in Kansas.*

	Grain Yield		Leaf Cl	
Variety	+ Cl	- Cl	+ Cl	- Cl
	------ bu/a ------		------ % ------	
Cimarron	75	59	0.44	0.10
Jagger	89	81	0.44	0.10
Karl 92	85	76	0.42	0.11
Ogallala	77	77	0.32	0.12
Tam 107	89	82	0.4	0.10
2137	90	84	0.42	0.11
2163	80	75	0.46	0.11
Average	84	76	0.42	0.11

* Average of five sites, all less than 20 lb/a soil Cl (0-24"), +Cl received 20 lb Cl/a as KCl fertilizer topdressed in February.

Table 2. Chloride fertilization on corn in Kansas.

Chloride Rate	Grain Yield: Riley Co. Site A	Riley Co. Site B	Riley Co. Site C	Brown Co. Site A	Brown Co. Site B	Brown Co. Site C	Osage Co. Site A	Osage Co. Site B
lb/a			bu/a					
0	70	64	107	188	123	87	133	79
20	84	69	111	191	130	93	133	81
Soil test Cl, lb/a (0-24")	9	16	24	28	14	28	40	61

Table 3. Chloride fertilization on wheat.

Chloride Rate	Grain Yield*: Marion Co. Site A	Marion Co. Site B	Saline Co Site A	Saline Co Site B	Saline Co Site C	Saline Co Site D	Stafford Co. Site A	Stafford Co. Site B	Avg.
lb/a				bu/a					
0	45	80	51	89	83	70	73	64	69
20	47	85	54	89	90	75	80	70	74
	7	7	14	22	7	14	7	15	12

*Average over either 12 or 16 varieties. Soil test Cl, lb/a (0-24")

Table 4. Chloride fertilization on grain sorghum in Kansas

Chloride Rate	Grain Yield: Marion Co. Site A	Marion Co. Site B	Marion Co. Site C	Marion Co. Site D	Brown Co. Site A	Brown Co. Site B	Osage Co. Site A	Osage Co. Site B
lb/a				bu/a				
0	87	117	63	92	102	87	125	88
10	94	139	71	113	106	95	126	92
20	97	135	72	126	111	96	125	96
Soil test Cl, lb/a (0-24")	9	7	9	43	7	9	52	29

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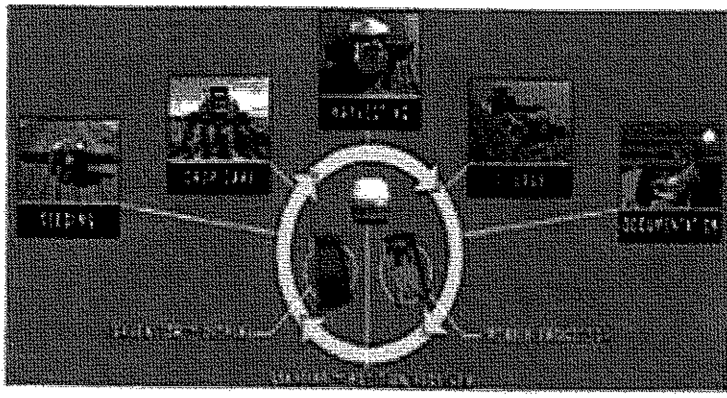

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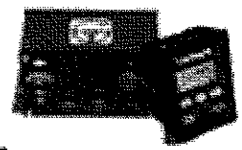

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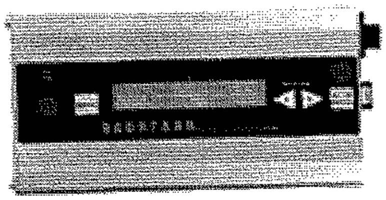

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