Cover Your Acres

Winter Conference

Cover Your Acres
Winter Conference

3rd Annual

February 2, 2006

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

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<tr><td>7:45 - 9:15</td><td colspan="3">Management of Jointed Goatgrass* – Room 1</td><td colspan="3">Registration</td></tr>
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<tr><td>4:05 – 4:53</td><td>Farmer Panel – Crop Rotations</td><td>Dryland Strip-till</td><td>Economic Impact of No-till on Land Rental Arrangements</td><td>Drift Control and Case IH Sprayers</td><td>The Future of Fertilizer</td></tr>
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*CEU credits for 1A for Commercial Pesticide Applicators have been approved.</td></tr>
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Coordinated by:
Brian Olson, K-State Extension Agronomist - NWREC
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 (President) at 785-693-4561

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GATEWAY

Oberlin, Kansas

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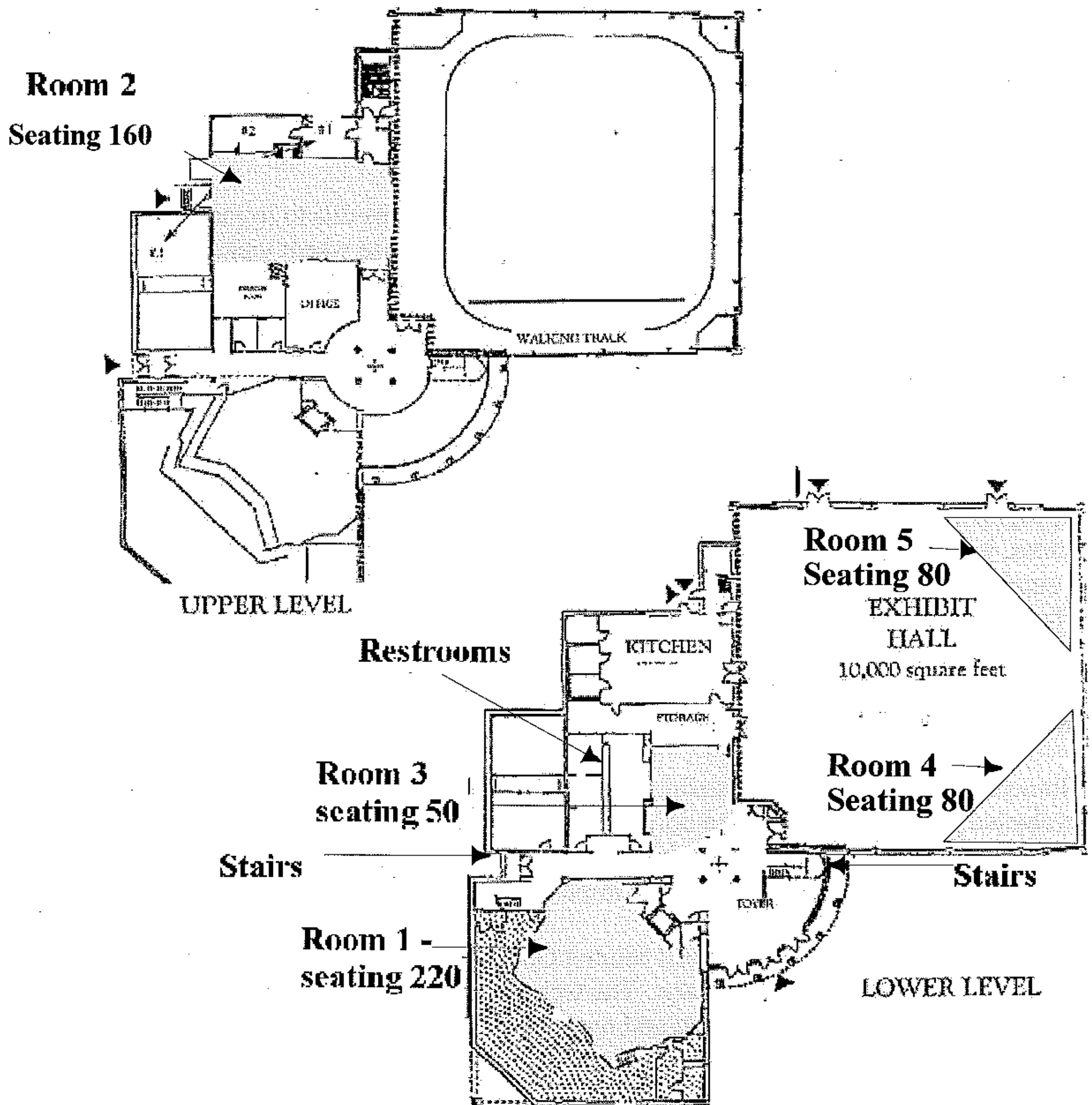

#1 Morgan Drive, Oberlin, Kansas 67749 785.475.2400 Fax 785.475.2925

The National Jointed Goatgrass Research Program
Who are we and what have we accomplished?

Tony White, Extension Coordinator

Jointed Goatgrass Management Session
Cover Your Acres Winter Conference, Oberlin KS.

Many growers in the central Great Plains and other parts of the western United States have recognized that jointed goatgrass is a serious problem in their winter wheat fields. Jointed goatgrass can be more problematic than other winter annual grasses because of its close genetic and life cycle similarities to winter wheat. Currently, over 5 million acres of winter wheat are infested with jointed goatgrass. These infestations are estimated to cost growers nearly $150 million dollars per year in lost revenue.

There are several reasons why growers suffer reduced profits due to jointed goatgrass infestations. Jointed goatgrass infestations commonly reduce wheat yields from 25 to 50%. Although these values are dependent on the jointed goatgrass population in the field and environmental conditions during the growing season, only a few jointed goatgrass plants per square yard are required to significantly reduce winter wheat yields. Other reasons why jointed goatgrass is a concern include increased grain dockage, loss of export market, decreased land value, increased tillage and conservation concerns, loss of certified seed market, and possible rotation to less profitable summer crops.

Recognizing that jointed goatgrass was a widespread problem in the western United States, in the early 1990's a group of scientists met as part of the Western Coordinating Committee (WCC-077) and formed the National Jointed Goatgrass Research Program. This program currently involves over 35 scientists from 11 states. The goal of this initiative is to make sure producers and others involved in jointed goatgrass management have the best and most recent information possible to successfully manage jointed goatgrass in winter wheat.

Numerous studies have been conducted as a part of this initiative. Scientists have evaluated jointed goatgrass seed dormancy and longevity, seed predation and disappearance over time, genetic similarities with winter wheat, and the use of single management components compared to implementing an integrated management system.

To find out more about the National Jointed Goatgrass Research Program, please visit us online at ***www.jointedgoatgrass.org***. The website contains more specific information regarding the program background and research projects, including basic biology and ecology information and management components. The website also lists national and state contact information if individuals have specific questions regarding jointed goatgrass in your area.

Jointed goatgrass Management: Importance of Cultural Practices

Phillip W. Stahlman
Research Weed Scientist
Kansas State University Agricultural Research Center-Hays

Jointed goatgrass problems are most severe in areas where winter wheat is grown continuously or in a wheat-fallow rotation. Cultural practices can influence jointed goatgrass management and reduce interference with winter wheat. Practices known to have an effect on jointed goatgrass management include crop rotation, wheat cultivar, seeding rate and row spacing, fertilizer timing and placement, tillage, and fallow management. Any practice that enhances the growth, vigor and competitiveness of crop plants should increase the effectiveness of cultural management of winter annual broadleaf and grass weeds, including jointed goatgrass. Single management practices seldom achieves more than about 25% suppression or reduction of jointed goatgrass populations, and effectiveness varies from year to year depending on environmental conditions. Individual effects are often additive, thus, the most effective management systems are those that integrate multiple control tactics into a comprehensive control plan covering multiple years.

The key to managing jointed goatgrass is to deplete the soil seed bank. One way to deplete the soil seed bank is by stimulating germination and destroying jointed goatgrass plants before they produce viable seed. Research in several states on the effectiveness of shallow tillage to stimulate germination by incorporating jointed goatgrass spikelets into soil in order to increase seed-soil contact has been inconsistent. The timing and amount of rainfall seems to be more important than tillage. Though tillage sometimes stimulates jointed goatgrass germination, tillage also may prolong the survival of a small percentage of seed by protecting them from environmental extremes and surface feeding predators.

Post-harvest tillage had a minimal effect on jointed goatgrass germination after wheat harvest in Nebraska, Oregon and Utah. Rainfall after harvest improved jointed goatgrass germination with tillage at North Platte, NE and Blue Creek UT, but low individual rainfall events in Moro, OR were insufficient to stimulate jointed goatgrass germination. This allowed the jointed goatgrass population to increase in the succeeding wheat crop. With high jointed goatgrass population density, the timing of tillage did not influence jointed goatgrass competition with winter wheat. Moldboard plowing or burning in the spring followed by moldboard plowing once was needed to reduce high jointed goatgrass populations to a manageable level in a winter wheat-fallow rotation. At Hays, KS and North Platte, NE, the number of jointed goatgrass plants destroyed during the fallow period following winter wheat was similar between chemical and mechanical fallow in most years, but mechanical fallow resulted in greater emergence compared with chemical fallow in droughty years.

Deep moldboard plowing that achieves complete soil inversion can bury most seed on the soil surface deep enough to prevent emergence. Most seeds will either decay or germinate at depths from which they can not emerge and become established. Few jointed goatgrass seeds survive burial more than four years. Subsequent tillage after deep plowing should be shallow to avoid bringing viable seed up to a depth from which germinating seedlings can emerge.

Isolated post-harvest burning of wheat stubble can a destroy jointed goatgrass spikelets in wind rows or in heavy crop residue, but spikelets on the soil surface may not be destroyed unless the burn is slow and intense. Low fuel load or rapid fire advancement may not generate enough heat at soil level to destroy the spikelets.

Studies in Kansas, Nebraska, Utah and Washington demonstrated that crop rotation was the most effective of several tactics tested for managing jointed goatgrass. Extending a wheat-fallow rotation to include grain sorghum (W-S-F) at Hays, KS or corn (W-C-F) at North Platte, NE dramatically reduced (but did not eliminate) jointed goatgrass populations in the following wheat crop. Further extending the rotation to include sunflower (W-S-SF-F) at Hays or a second year of corn (W-C-C-F) at North Platte nearly eliminated jointed goatgrass. Rotations that include spring crops are more effective than winter annual crops because spring crops break the natural life cycle of jointed goatgrass.

Numerous studies have shown that narrow crop row spacing and/or high seeding rates decrease the emergence, competitive ability, and seed production of weeds in winter wheat. Increasing seeding rate does not consistently lead to increased wheat yield under weed free conditions, but proportional yield increases have been consistently greater when weeds are present. Seeding rate had the most consistent effect on wheat yield in Washington, compared to plant height and seed size. Wheat seed yield was about 10% greater with seeding rates of 18 compared with 12 seed/ft of row when wheat competed with jointed goatgrass. Planting larger wheat seed often results in more rapid emergence and larger, more vigorous seedlings with greater root systems, particularly in the early-season growth stage, compared with seedlings from small seed. The advantage of large seed is more pronounced under dry conditions.

Wheat cultivars vary in competitiveness, with differences most often associated with plant height. In Washington, tall (~50 inches) wheat reduced mature jointed goatgrass biomass 46 and 16% compared to short (~39 inches) wheat in 1998 and 2000, respectively. Spikelet biomass and dockage were reduced approximately 70 and 30% in the same respective years when grown in competition with the taller compared with shorter wheat. Plant heights of modern high yielding varieties are less than they were a decade or more ago. Among modern varieties, studies have indicated the importance of rapid early growth and seedling size, in addition to plant height, when winter wheat is grown with jointed goatgrass. Winter wheat tiller number, canopy diameter, and height were negatively correlated with downy brome (*Bromus tectorum* L.) yield in Nebraska. Thus, varieties with traits of rapid emergence, vigorous and abundant fall vegetative growth, tallness, and wide canopy diameter likely will be the most competitive with weeds.

Integrating several tactics will suppress jointed goatgrass more than single cultural practices. In Colorado, winter wheat competition was increased six-fold by combining a tall cultivar with higher seeding rates and nitrogen placed in the crop row. When combined with a tall cultivar and a 40% increase in seeding rate, fertilizer placed directly in the seed row at planting reduced jointed goatgrass seed production nearly 45% compared to broadcast nitrogen application. However, because nitrogen can interfere with germination and reduce crop stand, care must be taken to minimize direct contact of the fertilizer and wheat seed.

In general, growers should prevent production of jointed goatgrass seed during fallow periods, increase wheat seeding rate, utilize narrow row spacing, apply starter fertilizer in or near the seed row, and plant a taller variety capable of rapid vegetative growth in fall to maximize jointed goatgrass suppression and crop yield.

Jointed Goatgrass Management: Other Tools Available

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Prevention. If you don't have it, don't get it!! The control of jointed goatgrass begins with eliminating seed sources. The following practices can eliminate jointed goatgrass seed sources:

1.) Plant clean seed. Jointed goatgrass spikelets are often found in fall-sown small grain seeds, especially winter wheat. It is almost impossible to separate all jointed goatgrass spikelets from winter wheat seeds; therefore, growers should be knowledgeable about their winter wheat seed source or buy only certified seeds. Jointed goatgrass spikelets can be identified in wheat grain or seed samples by placing the sample into a pail or plastic bag, adding water, and stirring or shaking; the wheat grain will sink and the jointed goatgrass spikelets will float.

2.) Destroy jointed goatgrass before it produces seeds. If plants reach the soft-dough stage the seeds probably will be viable. Jointed goatgrass may germinate as late as mid-April and still have sufficient cold weather to vernalize and produce seeds. Small plants, shorter than the wheat stubble, can produce viable seeds.

3.) Thoroughly clean combines and other machinery before moving from fields. Harvest fields in rotation with warm-season crops first since jointed goatgrass control in these fields is better.

4.) Control jointed goatgrass in roadside ditches and other areas that may contaminate the fields. This task may be aided by covering all trucks transporting winter wheat grain. New infestations are frequently found along roads where the light weight jointed goatgrass spikelets, which easily sift to the surface of the grain load, have blown out of uncovered grain trucks. Control may be accomplished with nonselective herbicides, mowing at the appropriate time, or tillage. Establishing a good stand of a perennial grass along roadsides can also serve as a way to prevent the establishment of jointed goatgrass.

5.) Run contaminated grain through a hammer mill before feeding to livestock. In a feeding study conducted in Nebraska, 76% of jointed goatgrass seeds collected from feces of cattle fed non-processed jointed goatgrass-contaminated wheat grain were viable. Using a fine-grind hammer mill setting using a 5/32-inch diameter screen reduced germination of the fed seed to zero.

6.) Do not remove straw and chaff from infested fields as they spread jointed goatgrass seeds. Jointed goatgrass spikelets are often blown out the back of a combine with the straw and chaff. If straw and chaff are removed with straw bales from infested fields, there is a good chance that seed will be spread to new locations.

7.) Spread manure from livestock only on fields in three- or four-year rotations with winter wheat or on fields that do not include winter wheat in the rotation. Viable jointed goatgrass seed may be spread in manure, so do not spread manure on fields where it will be difficult to control jointed goatgrass, for example, fields in a winter wheat-fallow or continuous wheat rotation.

Burning. Safety concerns, conservation compliance, air pollution, and soil erosion limit burning as a control measure for jointed goatgrass. Burning wheat stubble after harvest in Washington reduced the germination of seeds on the soil surface by up to 90 percent. However, wheat residues in Washington are typically greater than in western Kansas and Nebraska and they can fuel hotter and more sustained fire than is possible in this region. Surface soil temperatures of 200°F or more for up to 60 seconds provide the best control of jointed goatgrass seeds.

Mowing. Mowing should be done between the flowering and soft dough stages. If done too early, new tillers will form and produce viable seeds. Rough ground and the presence of prostrate jointed goatgrass plants may limit the effectiveness of mowing. Mowing multiple times may be required to achieve maximum control.

Managing Jointed GoatgrassWith Clearfield Wheat
Curtis Thompson, KSU Extension Crops and Soils, SW Kansas
Jointed Goatgrass Management Session
Cover Your Acres Conference – Oberlin 2006.

Prior to Clearfield wheat, no postemergence applied herbicides controlled jointed goatgrass (JGG). It is important to remember, however, that Clearfield wheat is only one tool for managing JGG.

Clearfield wheat is NOT a genetically modified organism (GMO). It can be marketed as any other conventional wheat crop. Clearfield wheat is the result of initially transferring the Clearfield gene from a French variety called "Fidel" into our adapted wheat varieties though conventional breeding.

Clearfield wheat was grown in the USA on less than 100,000 acres during the 2002-03 cropping season. The USA will have just under 800,000 acres during the 2005-06 season and acreage is expected to climb above 1.2 million acres in the 2006-07 season.

The area of adaptation of Clearfield wheat varieties has limited the Clearfield wheat acres grown in Kansas. The varieties Above (Colorado variety) and AP 502CL (AgriPro) were the first HRWW Clearfield varieties. With TAM 110 weighing heavily into the parentage, susceptibility to leaf and stripe rust, other leaf diseases and soil borne mosaic virus, these varieties are not adapted to South Central Kansas where the continuous wheat and the greatest winter annual grass problem occur. AP 401CL (AgriPro) is a white wheat with Platte in the pedigree adapted best for western Kansas. New varieties for Kansas include Bond CL (Colorado) which is a Yumar * Above sib cross susceptible to strip rust and wheat streak mosaic virus. Protection CL, a new AGSECO variety, has Jagger and a TAM 110 sib in its pedigree. It has stripe rust resistance but is susceptible to leaf rust. Infinity CL, a Nebraska variety, is medium late maturing with Millennium sib, Winstar, and Above sib in the pedigree. It is best adapted for Northwest Kansas and has stripe rust resistance but is susceptible to wheat streak mosaic virus. Additional Clearfield variety development especially in the area of disease resistance is needed to meet the needs of major Kansas wheat growing areas that have winter annual grass problems.

"Beyond" imazamox herbicide is used on Clearfield wheat to control winter annual grasses and broadleaf weeds. Beyond is in the imidazolinone herbicide family and its mode of action is an ALS inhibitor. Beyond currently is the most effective postemergence herbicide available for controlling jointed goatgrass in a Clearfield wheat crop.

Beyond must be applied to Clearfield wheat only because Beyond will kill conventional wheat varieties. Beyond can be applied from 4 to 6 fl oz/a with NIS and 1 to 50% UAN fertilizer to wheat in the tiller to jointing stage. Applications before tillering or after jointing can result in injury to the wheat crop. Beyond should not be tank mixed with other sulfonylurea herbicides (Glean, Ally, Finesse, Express, Harmony Extra, and others) or crop oil adjuvants to avoid excessive crop injury.

Research conducted near Manhattan KS by D. Peterson indicates that tank mixing Beyond with Finesse, fall or spring applied resulted in 22 to 43% wheat injury. Although this injury did not reduce wheat yield in this experiment, it suggests the potential for injury and yield reduction exists.

Research conducted near Hays by Stahlman etal. evaluates Beyond at 4, 5, and 6 oz applied to wheat early fall post (EFP), late fall post (LFP), early spring post (ESP) and late spring post (LSP). Wheat injury was observed at all timings, however, with fall applied treatments only 5 and 6 oz rates injured wheat 3 to 5%. Spring applied treatments injured wheat 7 to 32% with later applications and the higher Beyond rates causing the most injury. Clearly applications after jointing (LSP) resulted in the most wheat injury. The injury data was the average of two experiments. The 6 oz rate of Beyond reduced wheat yield 3 bu/a compared to wheat treated with 4 oz.a. Clearly the untreated weedy wheat was the lowest yielding treatment at 35 bu/a. No wheat yield reductions were observed with the fall applications as wheat averaged 46 bu/a. ESP treated wheat yielded 43 bu/a and LSP treated wheat yielded 36 bu/a. Wheat treated after the jointing stage had the greatest reduction in yield and the most visible crop injury.

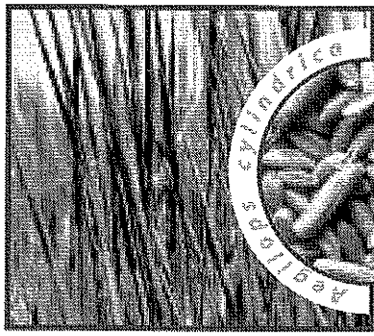
The Hays research indicates that fall application of Beyond controlled jointed JGG 97% or better. The ESP Beyond treatments controlled JGG 90 to 95%. The later spring treatments resulted in 70 to 80% control. When attempting to control weeds late in the spring in a big wheat crop, good coverage can become a real issue. This data suggests fall or early spring Beyond applications, prior to wheat jointing will give the best JGG control.

All herbicides/programs should be used in a way that will preserve the effectiveness of control over the longest period of time possible. The following is a discussion of the Stewardship Program for Clearfield wheat. The purpose of this program is to minimize the risk of herbicide resistant weed development.

It is required that certified or registered seed be used. Saving a part of the Clearfield wheat crop for seed is not legal. Beyond must be applied according to the label. It is recommended that continuous Clearfield wheat on a field should be avoided. A rotation using spring crops to break the winter grass life cycle is encouraged. This is true with or without Clearfield wheat. Using other herbicides with alternate modes of action (non – ALS) to reduce the risk of ALS resistant weed development is important. Crop rotation can facilitate the use of herbicides with alternate modes of action. During fallow periods do not allow the winter annual grasses to head! It is suggested that JGG in the areas around the field should also be controlled to reduce the risk of possible out crossing.

Can the Clearfield gene escape in to the JGG population? Wheat and JGG share a common "D" genome. As a result, wheat and JGG can cross producing hybrids. The hybrid, however, is male sterile. It is possible that wheat or JGG pollen can fertilize the male sterile flower resulting in a viable seed being produced. This occurrence would happen at very minute levels but it does indicate that growing continuous wheat, continuous Clearfield wheat, or continuous JGG could facilitate the escape of the Clearfield gene into the JGG natural population.

Currently there are no other types of herbicide resistant wheat available to producers. In the event that such a wheat would be developed, it too could be valuable to manage JGG.



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Jointed Goatgrass Control Tactics

Many winter wheat producers in the western United States rank jointed goatgrass as the most troublesome weed they must manage. Jointed goatgrass competes with a wheat crop, resulting in reduced yield and increased grain dockage. Genetic and life cycle similarities between jointed goatgrass and winter wheat makes jointed goatgrass control difficult.

Managing jointed goatgrass in winter wheat requires a systems approach that integrates multiple control tactics into a comprehensive management plan covering multiple years. This bulletin describes control tactics that can be used as part of integrated management systems to control jointed goatgrass. Similar control tactics are grouped into categories, such as seed bank management or prevention (Figure 1).

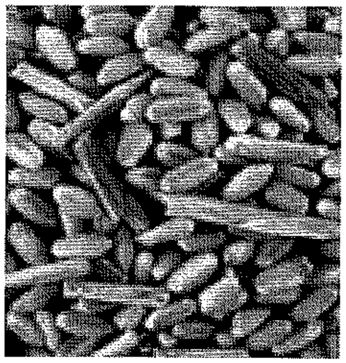
Jointed goatgrass infestations are seldom recognized before the problem is out of control. However, early awareness of the problem is essential for its control. Accurate identification of jointed goatgrass spikelets and plants in various growth stages is critical to early detection. Jointed goatgrass identification is a challenge because the weed is similar in appearance to winter wheat. However, there are differences. Jointed goatgrass seedlings have evenly spaced hairs lining the leaf blade margin and winter wheat does not. The jointed goatgrass seed, often referred to as a spikelet or joint, is distinctly different from wheat and can aid in identification. EB 1932, "Jointed Goatgrass Ecology," plant identification guides (books, pamphlets and web-based publications), and local extension specialists are excellent resources to help identify jointed goatgrass.

Prevention

A critical aspect of jointed goatgrass management is to prevent seed entry into fields and isolate minor infestations within the field. Jointed goatgrass seeds are usually enclosed within a spikelet, which resembles a short piece of wheat straw and is easily overlooked in bulk grain (Figure 2). Planting wheat contaminated with jointed goatgrass spikelets rapidly expands the area infested with jointed goatgrass. Moreover, contaminated wheat seed will be planted over entire fields or farms, making isolation difficult. Planting jointed goatgrass-free seed can prevent the initial infestation and reduce or help stop the spread of an existing problem.

Figure 1. Various control strategies can be used to reduce jointed goatgrass densities. Integrating multiple strategies into a management plan reduces jointed goatgrass populations more than use of single strategies alone.

Figure 2. Jointed goatgrass spikelets (seed) resemble wheat straw, are difficult to separate from wheat grain, and increase dockage at the grain terminal.



Field borders, roadsides, railroad tracks, and other rights-of-way should be inspected for jointed goatgrass and control measures applied if necessary. Once plants establish along these areas, spikelets can move into crop fields by precipitation runoff, tillage implements, or animals.

Farm trucks are commonly used for multiple purposes, such as hauling harvested grain, fertilizer, and bulk seed wheat. Thoroughly cleaning trucks and equipment used for grain or fertilizer hauling between different uses is a good management practice. If contaminated seed or fertilizer is used for planting crops other than winter wheat, jointed goatgrass seed could remain dormant and establish in a subsequent winter crop.

As a load of wheat contaminated with jointed goatgrass travels down the road, jointed goatgrass spikelets migrate towards the top of the load because they are lighter than wheat seeds. Once they have moved to the top of the load, the spikelets are easily blown out of an uncovered load and fall along the roadside. Covering loaded trucks or wagons thought to contain contaminated wheat is a good management practice and a good neighbor policy.

Movement by machinery also spreads jointed goatgrass within and between fields. For example, combines can rapidly disperse jointed goatgrass seeds throughout a field (Figure 3). Scientists in Australia evaluated seed dispersal of wild oat and downy brome (also called cheatgrass) and found that combine seed dispersal increased the area of infestation 16-fold in only one year, compared with a system where seed dispersal at harvest was prevented.

Field scouting can identify areas in fields that may be infested with jointed goatgrass. Jointed goatgrass commonly occurs in patches within fields. Harvesting these patches along with weed-free sections of the field will disperse jointed goatgrass into non-infested areas. Those areas should be marked and harvested last so that seed dispersal within the field will be minimized. Equipment should be cleaned before moving from infested fields. Custom harvesters should be required to clean combines and trucks prior to entry into fields.

Harvesting contaminated field edges with a combine will spread jointed goatgrass seed throughout the remainder of the field. Perennial grasses could be maintained around field edges or borders to reduce jointed goatgrass establishment and seed production. However, it is also important to avoid grasses that can provide refuge for wheat pests, such as aphids or the wheat curl mite. Please contact your local state extension specialist for additional information on perennial grass species adapted for your area.

Mowing. Mowing can be a useful tool for managing jointed goatgrass infestations in

Figure 3. Jointed goatgrass can be easily spread through normal harvest operations.

roadsides, fencerows, and non-cropland areas, but timing is essential. Two separate cuttings at specific times in the season may be required to prevent jointed goatgrass from producing seed. Mowing is most effective when jointed goatgrass seed heads begin to emerge. Mowing too late may allow jointed goatgrass to produce viable seed. However, mowing too early (early joint stage) may allow jointed goatgrass plants to regrow and produce seed. Because of variable effectiveness, mowing is not recommended for jointed goatgrass control in a field situation unless it is the only alternative.

Another option is to not plant the outer edge of the field to winter wheat, but to leave this border fallow until a spring small grains or summer crop can be planted. This method may also provide greater revenue. An alternative crop in these areas also allows tillage or herbicides to be used in the spring to control jointed goatgrass. However, a disadvantage is that the alternative and winter wheat crops may not mature at the same time, requiring a second trip to harvest the alternative crop.

Feeding Jointed Goatgrass to Livestock. Wheat contaminated with jointed goatgrass seed is often heavily docked or rejected by grain purchasers. Scientists in Nebraska investigated jointed goatgrass-contaminated wheat as a potential livestock feed. Jointed goatgrass seed contains a protein content near 12% and they found that it makes a suitable alternative for livestock feed. Feed mixtures containing jointed goatgrass must be processed in a fine-grind hammer mill to eliminate the germinability of the jointed goatgrass seed. Failure to do so may result in a larger weed problem if seed is spread in livestock manure.

Herbicides

Non-Selective. Many postemergence non-selective herbicides, such as glyphosate, can control jointed goatgrass and other winter annual grasses found in fallow fields. Check product labels or consult with your local crop consultant, extension specialist, or pesticide retailer for specific recommendations in your area. Burndown herbicides used in no-tillage cropping systems should be applied early enough to allow complete jointed goatgrass control before planting the subsequent crop.

Selective. Selective herbicides are available in other crops to control jointed goatgrass, but are not currently registered for use in conventional (non-herbicide resistant) winter wheat. Jointed goatgrass is genetically related to winter wheat and cannot be controlled by herbicides without causing unacceptable crop injury. Finding a herbicide that would control jointed goatgrass in conventional wheat is unlikely, given the high cost of developing and marketing such a product. Current industry efforts are focusing on herbicide-resistant wheat technology.

Clearfield Wheat Technology. The recently developed Clearfield™ wheat system offers growers an effective method to selectively control jointed goatgrass in herbicide-resistant winter wheat. Clearfield™ wheat varieties are rapidly being developed that combine herbicide tolerance to imidazolinone herbicides with desirable traits from current wheat varieties. This technology allows Beyond™ (imazamox) herbicide to be used for control of jointed goatgrass and other weeds in wheat.

Beyond™ herbicide should be applied early postemergence to Clearfield™ wheat between the three-leaf stage and prior to jointing at rates specified by the product label. Applications should be made when maximum daytime temperatures are greater than 40°F to optimize weed control and reduce potential crop injury. Weeds should be actively growing and less than 3 inches tall. Refer to the Beyond™ product use label for proper adjuvant systems. Conventional (non-Clearfield™) wheat varieties will be seriously injured or killed if sprayed with Beyond™ herbicide. Beyond™ can be applied in the fall or spring, but the optimum application timing is region-specific. In addition to controlling jointed goatgrass, Beyond™ controls several other winter annual grass and broadleaf weeds. Region-specific application information, Clearfield™ wheat seed varieties, and costs are available through local agricultural product retail centers.

Clearfield™ wheat varieties must be locally adapted. In the Pacific Northwest, for example, a farmer may be better off to plant a locally adapted spring wheat to prevent a jointed goatgrass infestation than using a poorly adapted Clearfield™ variety as part of a management program. Producers throughout the western United States will have access to improved Clearfield™ wheat varieties within the next few years.

Seed Bank Management

Tillage to Stimulate Germination. Jointed goatgrass management is complex because seed survival in the soil can vary depending on annual rainfall. If seed numbers in soil can be reduced, then fewer seedlings will infest future winter wheat crops. Producers often observe flushes of seedlings soon after tillage, which can stimulate jointed goatgrass seed germination in the soil. Germination reduces the density of remaining seeds in the soil, but tillage may prolong the survival of some remaining seeds by burying them in soil and protecting them from environmental extremes and surface-feeding predators.

Scientists in Utah, Oregon, and Nebraska tested the effect of shallow tillage as a management option. Tillage operations were tested throughout the emergence period of jointed goatgrass, which generally occurs between September and April. No-till, single, and multiple tillage operations were evaluated and jointed goatgrass densities recorded in the following winter wheat crop.

The scientists concluded that single or multiple tillage operations were inconsistent in reducing jointed goatgrass seed bank density. Environmental conditions, especially timing and amount of rainfall, were more important than tillage in these studies. Differences among treatments were small at all sites, suggesting shallow tillage exerts a minor effect on seed bank density over time. Similar results have been reported in Kansas and Colorado. These studies suggest tillage may not be effective for managing jointed goatgrass seed in the soil. Producers will reduce jointed goatgrass infestations more with diverse crop rotations, competitive wheat canopies, and Beyond™ herbicide than with tillage. Tillage is not only inconsistent for managing jointed goatgrass, but can increase vulnerability to soil erosion. Tillage reduces straw residue remaining on the soil surface, increasing the risk of wind or water erosion.

Managing Fields with High Jointed Goatgrass Densities. Jointed goatgrass infestations in cropland may become so high that producers rely on extreme measures to reduce seed density in the soil. One option is to burn winter wheat residue lying on the soil surface after harvest. If sufficient heat is generated, burning will kill jointed goatgrass seeds. The effectiveness of this strategy is related to the quantity of residue (fuel load), with at least 5,000 pounds of residue per acre required to reach lethal temperatures. Jointed goatgrass seedling density in the following year can be reduced 80 to 90%. However, burning residue only kills jointed goatgrass seeds lying in residue on the soil surface; seeds buried in soil are protected from the lethal heat. A further consequence of burning is that soils are more prone to erosion when crop residue is removed. Field burning may also be prohibited or restricted in some areas. Always follow applicable laws and obtain necessary permits prior to burning.

A second management option is moldboard plowing (complete soil inversion), as jointed goatgrass seedlings cannot emerge after germination if buried at least 6 inches deep. Moldboard plowing can bury up to 90% of seeds laying on the soil surface deep enough to reduce seedling density in the following winter wheat crop. Shallow tillage after deep plowing will reduce the risk of bringing jointed goatgrass seeds back to the soil surface where they can germinate.

Do not moldboard plow more than once every four years or the benefits of plowing will be minimized. Most jointed goatgrass seeds do not survive longer than four years when buried deep in soil, but may survive longer in drier soil conditions. Therefore, moldboard plowing in shorter intervals (less than four years) may bring live seeds back to the soil surface. Moldboard plowing, as well as burning, may be most useful for small areas of dense infestations, but eliminates surface residue and can make soil more susceptible to erosion. Given potential restrictions in burning or moldboard plowing, farmers will want to carefully evaluate which fields will benefit most from these management practices.

Crop Management

When winter wheat and jointed goatgrass grow together, the plants emerging first will capture resources such as water or nitrogen in the soil and will gain a competitive advantage. Producers can favor the competitiveness of winter wheat over jointed goatgrass with cultural practices that stimulate rapid emergence and vigorous seedling growth. For example, deep-banding nitrogen fertilizer near winter wheat seed at planting can stimulate the wheat and reduce jointed goatgrass growth up to 15%. Also, banding a small amount of phosphorus fertilizer with the seed can stimulate wheat seedling growth, even in soils with adequate phosphorus levels.

Improved Planting Techniques. Planting larger wheat seed can also increase wheat seedling size and vigor. Planting 50% more seed than standard recommendations and using a row spacing of 7 inches or less can also increase crop competitiveness with weeds. Similarly, planting winter wheat cultivars that are taller, tiller more profusely, and initiate growth earlier in the spring can reduce jointed goatgrass growth by 5–25%. Increasing seeding rates and using narrow row spacing works best in areas that receive at least 20 inches of annual rainfall. These practices should be used with caution in low rainfall areas and during periods of drought, as excessive early crop growth can deplete soil moisture needed later for grain fill.

Relying on a single cultural practice in winter wheat is an ineffective approach towards managing jointed goatgrass. Jointed goatgrass suppression seldom exceeds 25% when using individual practices such as using a higher seeding rate, planting larger-sized seed, planting in narrower rows, or banding phosphorus with the seed at planting. In addition, the effects of specific cultural practices are not consistent over years, varying with environmental conditions and jointed goatgrass emergence timing relative to wheat. Jointed goatgrass that emerges before, simultaneously, or within one week after wheat emerges will be the most competitive. Any condition that decreases wheat density or slows wheat growth will decrease the effectiveness of cultural control practices. For example, drought conditions that delay wheat emergence and reduce wheat populations will allow jointed goatgrass to flourish.

Integrating several tactics will suppress jointed goatgrass more than single cultural practices implemented individually. Winter wheat competition with jointed goatgrass in Colorado was increased six-fold by combining a tall cultivar with higher seeding rates and nitrogen placed in the crop row. When combined with a tall cultivar and a 40% increase in seeding rate, fertilizer placed directly in the seed row at planting reduced jointed goatgrass seed production nearly 45% compared to a broadcast nitrogen application. However, placing nitrogen fertilizer in the seed row can lead to injury of germinating crop seeds in most regions and is not considered a good management practice.

Not all jointed goatgrass will be controlled with cultural practices and surviving plants can produce many seeds, even with improved cultural systems. Multiple practices must be combined in an integrated management program and sustained over time (years) to be effective against jointed goatgrass.

Crop Rotations

Most jointed goatgrass problems are found in areas where winter wheat-fallow or continuous wheat are common crop rotations. Implementing a winter wheat-fallow rotation alone will not provide a means to break the natural life cycle of jointed goatgrass, nor deplete the level of jointed goatgrass seed in the soil. Producers can reduce jointed goatgrass seed density in the soil by rotating from winter wheat to crops with different growth requirements, such as spring or summer crops. This tactic lengthens the interval between winter wheat crops, thus favoring the natural decline of jointed goatgrass seed density in the soil. About 30% of jointed goatgrass seeds are alive after two years in the soil, but fewer than 10% of the seeds typically survive for three years. EB1932, "Jointed Goatgrass Ecology," provides additional information on seed survival.

Producers in the Pacific Northwest have utilized the positive impacts of crop rotation on jointed goatgrass management by adding barley or spring wheat to a continuous winter wheat or winter wheat-fallow rotation. However, one limitation with spring small grain cereal crops is that jointed goatgrass plants may still become established in these crops, produce seeds, and lessen the effect of crop diversity. Adding pea, lentil, canola, or mustard to the crop rotation is more effective because the growing season is different than for jointed goatgrass and selective grass herbicides can be used, if necessary, to control jointed goatgrass.

In Utah, adding safflower to the winter wheat-fallow rotation is effective because producers can control jointed goatgrass both before planting and during the season safflower is grown (Figure 4). In the central Great Plains, producers can include summer annual crops such as corn (maize), sorghum, proso millet, soybean, or sunflower in the rotation (Figure 5). The later planting dates of these crops enable producers to eliminate any jointed goatgrass that emerged during the previous winter by using tillage or applying herbicides. By using rotations that include two summer

Figure 4. Adding safflower to the winter wheat-fallow provides an option for producers to reduce the seedbank density of jointed goatgrass while maximizing profitability.

annual crops in a winter wheat-fallow rotation, such as winter wheat-corn-sunflower-fallow, producers have nearly eliminated jointed goatgrass in most fields. An option in the southern Great Plains is to add sorghum to the winter wheat-fallow rotation. The positive impacts of using different crops in rotation for jointed goatgrass control must be balanced with economic feasibility.

Integration of Multiple Control Tactics

A variety of control tactics are available to help producers manage jointed goatgrass. A key lesson learned from years of research with jointed goatgrass is the need for integrated management systems comprised of several tactics. Effective management requires implementing practices from all possible control categories. Jointed goatgrass density has been reduced more than 90% with regional integrated management programs where multiple tactics were used in three- or four-year crop rotations. Scientists continue to evaluate the effects of comprehensive management systems on jointed goatgrass. Producers are encouraged to review other jointed goatgrass bulletins that describe the Best Management Practices (BMPs) for their region, or visit the National Jonted Goatgrass Research Program website at www.jointedgoatgrass.org.

Figure 5. Summer annual crops, such as grain sorghum, offer Great Plains producers an opportunity to add crops with a different life cycle to the winter wheat-fallow rotation.

Photo Credits
Figure 2, courtesy of the Jointed Goatgrass Research Program; Figure 3, courtesy of Washington State University Extension; Figure 4, courtesy of USDA-ARS Image Gallery; Figure 5, courtesy of USDA, photographer Ken Hammond.

FOUR YEAR CROP ROTATIONS WITH WHEAT AND GRAIN SORGHUM

Alan Schlegel and Troy Dumler
Kansas State University

SUMMARY

Research on 4-yr crop rotations with wheat and grain sorghum was initiated at the K-State Southwest Research-Extension Center near Tribune in 1996. The rotations were wheat-wheat-sorghum-fallow (WWSF) and wheat-sorghum-sorghum-fallow (WSSF), along with continuous wheat (WW). Soil water at wheat planting averages about 9 inches following sorghum which is about 3 inches more than the second wheat crop in a WWSF rotation. Soil water at sorghum planting is about 1.5 inches less for the second sorghum crop compared to sorghum following wheat. Fallow efficiency was greater for the shorter fallow period following wheat than for the longer fallow following sorghum. Following sorghum, fallow efficiency prior to wheat averaged 25% compared with 35% in WW and 43% for the second wheat crop in a WWSF rotation. Prior to sorghum, fallow efficiency was 36 to 38% and not affected by previous crop. Grain yield of continuous wheat averages about 78% of the yield of wheat grown in a 4-yr rotation following sorghum. Except for one year, there has been no difference in yield of continuous wheat and recrop wheat grown in a WWSF rotation. Yields are similar for wheat following one or two sorghum crops. Similarly, average sorghum yields were the same when following one or two wheat crops. Yield of the second sorghum crop in a WSSF rotation averages 73% of the yield of the first crop.

INTRODUCTION

In recent years, cropping intensity has increased in dryland systems in western Kansas. The traditional wheat-fallow system is being replaced by wheat-summer crop-fallow rotations. With concurrent increases in no-tillage, the question arises as to whether more intensive cropping is feasible. The objectives of this research were to quantify soil water storage, crop water use, crop productivity, and profitability of 4-yr and continuous cropping systems.

MATERIALS AND METHODS

Research on 4-yr crop rotations with wheat and grain sorghum was initiated at the K-State Southwest Research-Extension Center near Tribune in 1996. The rotations were wheat-wheat-sorghum-fallow and wheat-sorghum-sorghum-fallow, along with a continuous wheat rotation. No-till was used for all rotations. Available water was measure in the soil profile (0 to 8 ft) at planting and harvest of each crop. The center of each plot was machine harvested after physiological maturity and yields adjusted to 12.5% moisture.

RESULTS AND DISCUSSION

Soil water

The amount of available water in the soil profile (0 to 8 ft) at wheat planting varied greatly from year-to-year (Fig. 1). Soil water was similar following fallow after either one or two sorghum crops and averaged, across the 9-yr period, about 9 inches. Water at wheat planting of the second wheat crop in a WWSF rotation was always less than the first wheat crop except in 2003, which had the lowest water content at planting of any year. Soil water for the second wheat crop averaged almost 3 inches (or about 30%) less than the first wheat crop in the rotation. Continuous wheat averaged about 1 inch less water at planting than the second wheat crop in a WWSF rotation. Fallow efficiency (amount of water accumulated from previous harvest to planting of current crop divided by precipitation during fallow) ranged from less than 0 to more than 60%. Fallow efficiency was greater for the shorter (3 month) fallow period following wheat than for the longer (11 month) fallow following sorghum. Following sorghum, fallow efficiency averaged 25% compared with 35% in WW and 43% for the second wheat crop in a WWSF rotation.

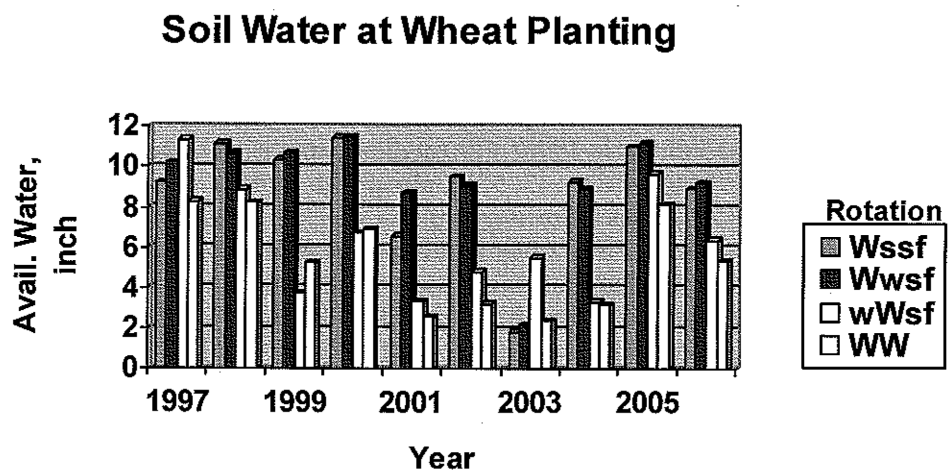


Figure 1. Available soil water at planting of wheat in several rotations, 1997-2005, Tribune, KS. Last bars are averages across years. Letter capitalized denotes current crop in rotation.

Similar to wheat, the amount of available water in the soil profile at sorghum planting varied greatly from year-to-year (Fig. 2). Soil water was similar following fallow after either one or two wheat crops and averaged (10-yr) about 8.6 inches. Water at planting of the second sorghum crop in a WSSF rotation was always less than the first sorghum crop although sometimes by very little. For instance, in 1998, there was less than 0.25 inch difference between them. When averaged across the entire study period, the first sorghum crop had 1.35 inch more available water at planting than did the second crop. Similar to wheat, fallow efficiency prior to sorghum ranged from less than 0 to more than 60%. In contrast, to wheat, average fallow efficiency prior to sorghum was similar following wheat or sorghum at 36 to 38%.

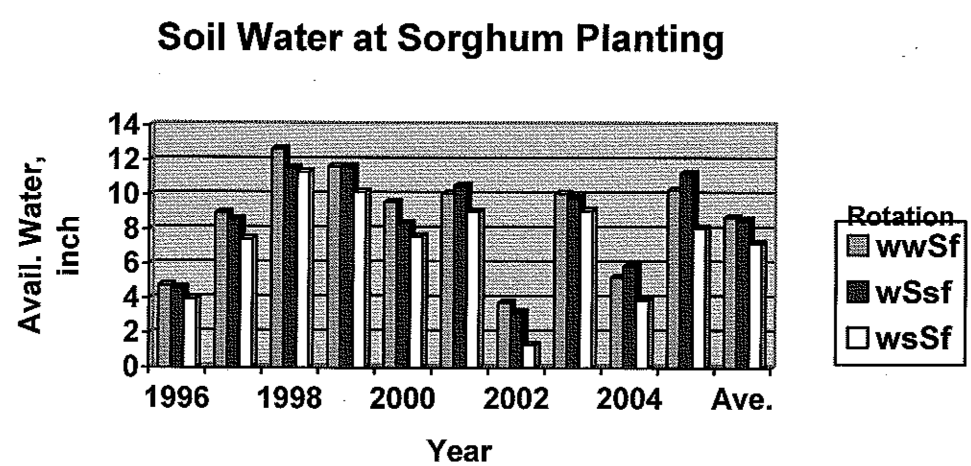


Figure 2. Available soil water at planting of sorghum in several rotations, 1996-2005, Tribune, KS. Letter capitalized denotes current crop in rotation.

Grain yields

Wheat yields were above the long-term average in 2005 (Table 1). Averaged across 9 years, recrop wheat (the second wheat crop in a WWSF rotation) yielded about 90% of the yield of first-year wheat in either WWSF or WSSF rotations. Before 2003, recrop wheat yielded about 70% of the yield of first-year wheat. In 2003, however, the recrop wheat yields were more than double the yield in all other rotations. This is possibly due to the failure of the first-year wheat in 2002, resulting in a period from 2000 sorghum harvest to 2003 wheat planting without a harvestable crop. There has been no difference in wheat yields following one or two sorghum crops. The continuous-wheat yields have been similar to recrop wheat yields, except in 2003.

Table 1. Wheat response to rotation, Tribune, Kansas, 1997 through 2005.

Rotation*	1997	1998	1999	2000	2001	2002	2003	2004	2005	Mean
	------------------ bu/a ------------------									
Wssf	57	70	74	46	22	0	29	6	45	39
Wwsf	55	64	80	35	29	0	27	6	40	37
wWsf	48	63	41	18	27	0	66	1	41	34
WW	43	60	43	18	34	0	30	1	44	30
LSD (0.05)	8	12	14	10	14	--	14	2	10	3

* Capital letters denote current-year crop.

Sorghum yields in 2005 were greater than the long-term yield average for each rotation (Table 2). The recrop sorghum yield averages about 73% of the yield of the first sorghum crop following wheat; in 2005, however, recrop yields were 85% of the first-year sorghum yield. Although variable from year to year, average sorghum yields were the same following one or two wheat crops.

Table 2. Grain sorghum response to rotation, Tribune, Kansas, 1996 through 2005

Rotation*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Mean
	------------------ bu/a ------------------										
wSsf	58	88	117	99	63	68	0	60	91	81	72
wsSf	35	45	100	74	23	66	0	41	79	69	53
wwSf	54	80	109	90	67	73	0	76	82	85	72
LSD (0.05)	24	13	12	11	16	18	--	18	17	20	4

* Capital letters denote current year crop.

An economic analysis using current costs and average annual commodity prices from 1996 through 2004 was conducted to determine which rotation had the greatestt return to land and management. The estimated returns do not include government payments or insurance indemnity payments. Average returns from 1996 through 2004 were $-9.84, $-11.97, and $-16.54 for the WWSF, WSSF, and WW rotations, respectively. If the disaster year of 2002 is removed, however, returns averaged $34.91, $47.77, and $-7.91, respectively, for the WWSF, WSSF, and WW rotations.

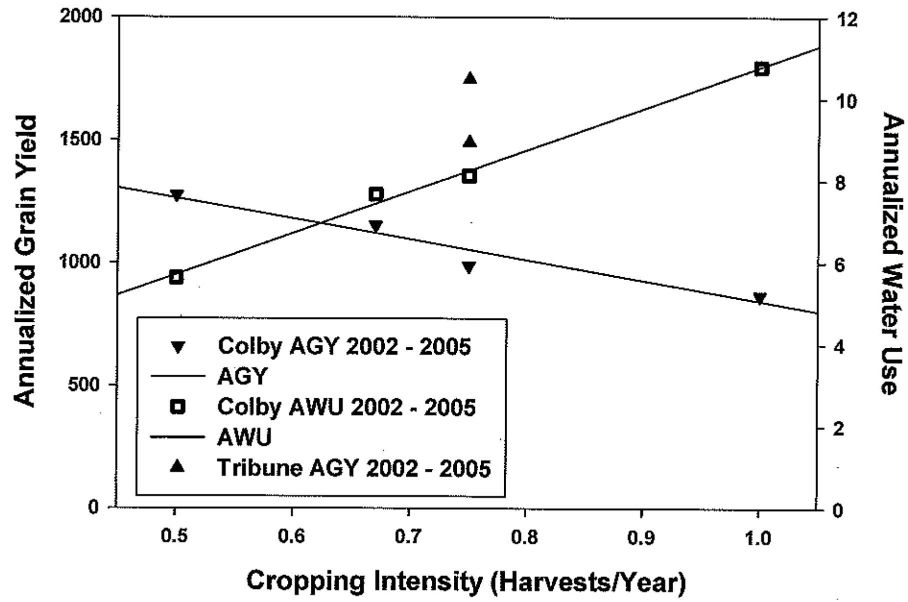
Cropping intensity, water use and productivity under drought conditions

Rob Aiken
K-State Northwest Research—Extension Center

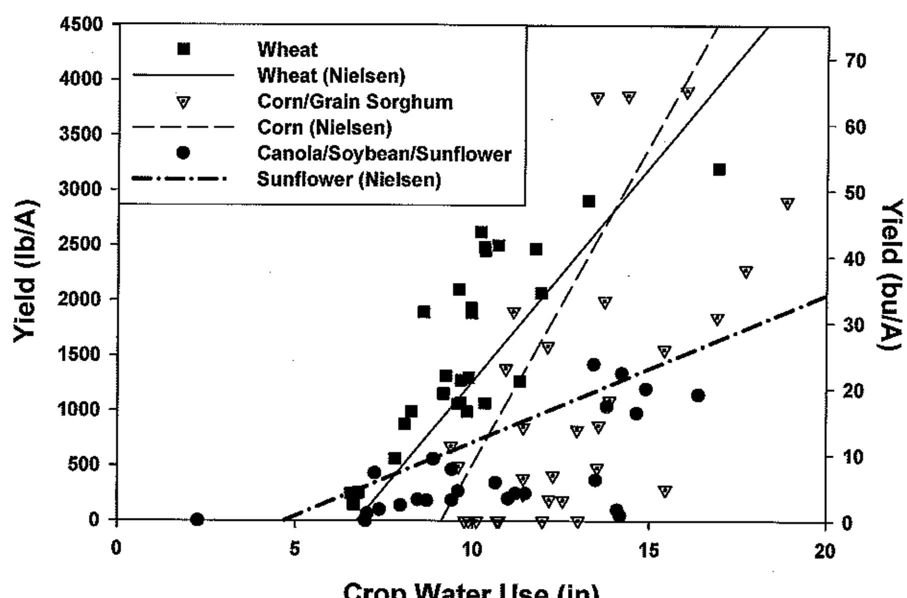
Summary

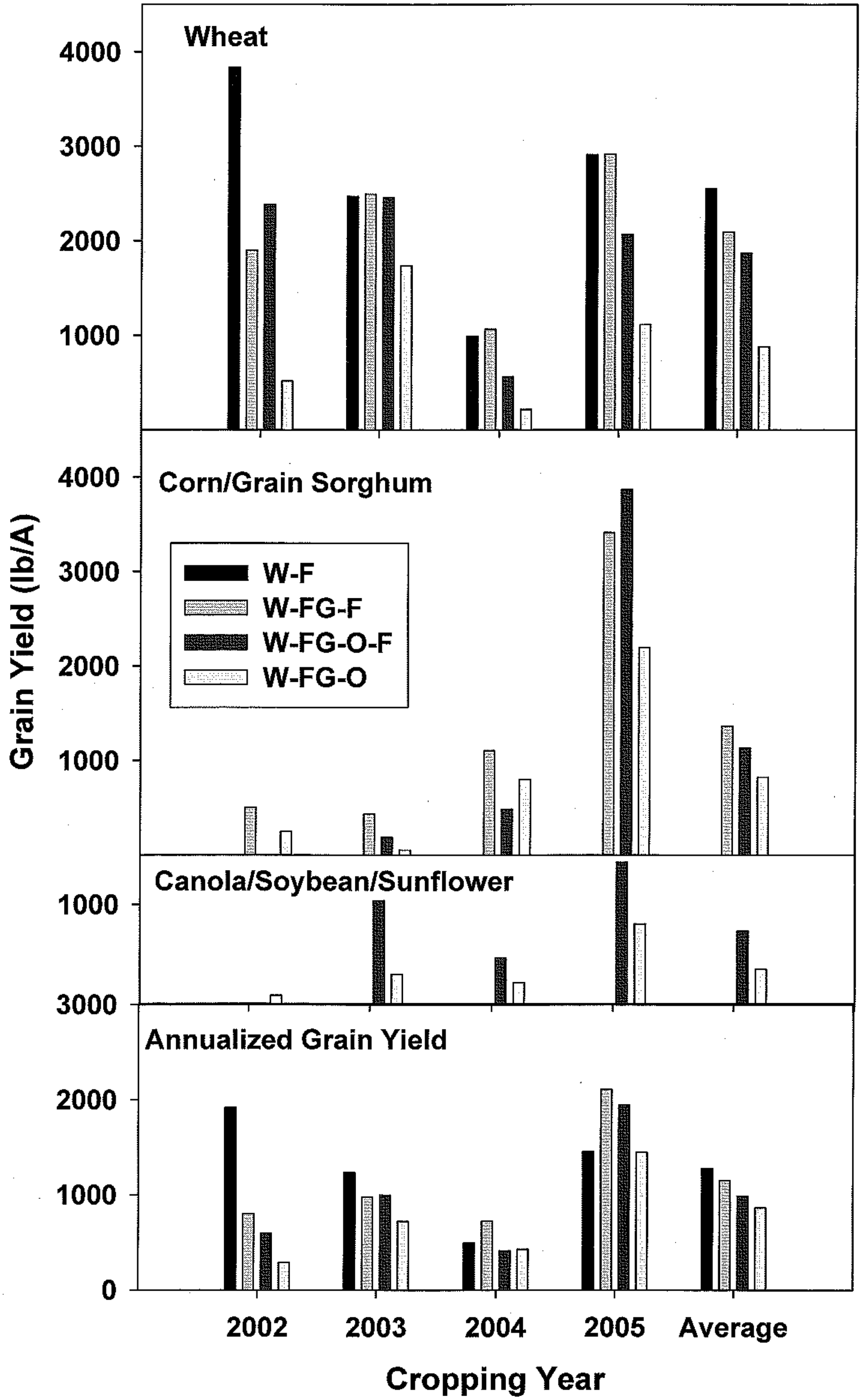
Intensive (continuous) cropping systems can increase the fraction of precipitation available to cropping systems; but also increase risk of crop failure. Long-term rotations were established to compare effects of cropping intensity (wheat-fallow to continuous cropping) on crop water use and grain productivity in dryland semi-arid regions. Wheat yields were critical to grain productivity under drought conditions (2002 – 2005) as corn and grain sorghum crops failed in three of four years. Annualized crop water use (inches per year in rotation cycle) nearly doubled with increased cropping intensity. However, grain productivity decreased by 32% due to reduced wheat yields and failure of feed grain or oilseed yields to compensate. Annualized grain yields of more intensive cropping matched or exceeded productivity of wheat-fallow when corn or grain sorghum water use exceeded 14".

- Cropping intensity ranged from 0.5 (one wheat crop in two years) to 1.0 (one crop each year).
- Annualized water use (total inches used by all crops in a rotation, divided by number of years in a complete rotation cycle) increased with cropping intensity.
- Annualized grain yield (total grain produced by all crops, divided by number of years in rotation cycle) decreased with cropping intensity.



- Crop water use (precipitation from emergence to harvest, plus change in stored soil water) ranged from 7" to 18".
- Expected yields (lines) taken from D. Nielsen, Central Plains Research Station, Akron, CO.
- Corn and grain sorghum yields were frequently less than expected.





Wheat
Corn/Grain Sorghum
Canola/Soybean/Sunflower
Annualized Grain Yield
W-F
W-FG-F
W-FG-O-F
W-FG-O
4000
3000
2000
1000
0
Grain Yield (lb/A)
2002
2003
2004
2005
Average
Cropping Year

CROP RESIDUE AND SOIL WATER

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INTRODUCTION

Final crop yield is greatly influenced by the amount of water that moves from the soil, through the plant, and out into the atmosphere (transpiration). Generally, the more water that is in the soil and available for transpiration, the greater the yield. For example, dryland wheat yield is strongly tied to the amount of soil water available at wheat planting time (Fig. 1). In this case an additional inch of water stored in the soil at wheat planting time would increase yield by 5.3 bu/a. For wheat selling at $3.21/bu, that inch of stored soil water is worth $17/a. Similar relationships can be defined for other crops. But the point is that in the Great Plains where precipitation is low and erratic, an important production factor is storing as much of the precipitation and irrigation that hits the soil surface as possible.

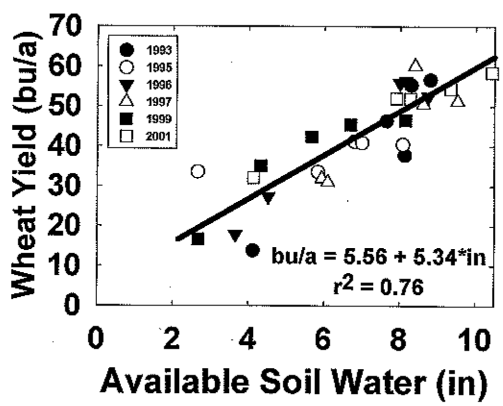

Fig. 1. Relationship between winter wheat grain yield and available soil water at wheat planting at Akron, CO.

FACTORS AFFECTING WATER STORAGE

Time of Year/Soil Water Content

The amount of precipitation that finally is stored in the soil is determined by the precipitation storage efficiency (PSE). PSE can vary with time of year and the water content of the soil surface. During the summer months air temperature is very warm, with evaporation of precipitation occurring quickly before the water can move below the soil surface. Farahani et al. (1998) showed that precipitation storage efficiency during the 2 ½ months (July 1 to Sept 15) following wheat harvest averaged 9%, and increased to 66% over the fall, winter, and spring period (Sept 16 to April 30) (Fig. 2). The higher PSE during the fall, winter, and spring is due to cooler temperatures, shorter days, and snow catch by crop residue. From May 1 to Sept 15, the second summerfallow period, precipitation storage efficiency averaged -13% as water that had been previously stored was actually lost from the soil. The soil surface is wetter during the second summerfallow period, slowing infiltration rate, and increasing the potential for water loss by evaporation.

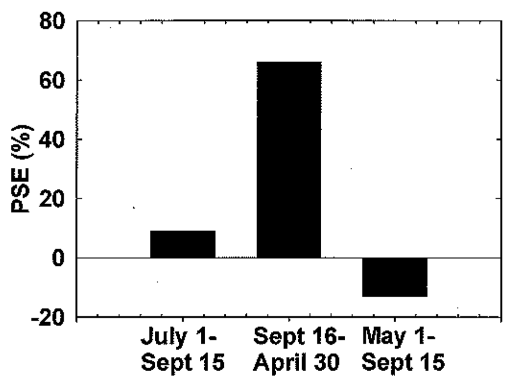

Fig. 2. Precipitation Storage Efficiency (PSE) variability with time of year. (after Farahani, 1998)

Residue Mass and Orientation

Studies conducted in Sidney, MT, Akron, CO, and North Platte, NE (Fig. 3) demonstrated the effect of increasing amount of wheat residue on the precipitation storage efficiency over the 14-month fallow period between wheat crops.

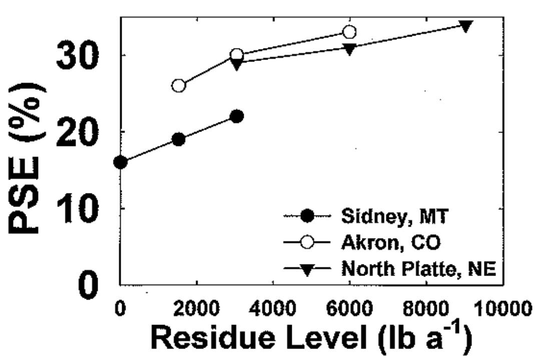

Fig. 3. Precipitation Storage Efficiency (PSE) as influenced by wheat residue on the soil surface. (after Greb et al., 1967)

As wheat residue on the soil surface increased from 0 to 9000 lb/a, precipitation storage efficiency increased from 15% to 35%. Crop residues reduce soil water evaporation by shading the soil surface and reducing convective exchange of water vapor at the soil-atmosphere interface. Additionally, reducing tillage and maintaining surface residues reduce precipitation runoff, increase infiltration, and minimize the number of times moist soil is brought to the surface, thereby increasing precipitation storage efficiency (Fig. 4).

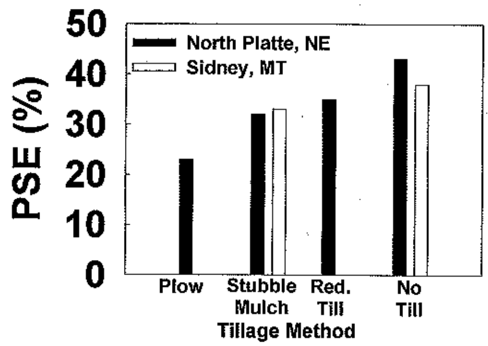

Fig. 4. Precipitation Storage Efficiency (PSE) as influenced by tillage method in the 14-month fallow period in a winter wheat-fallow production system. (after Smika and Wicks, 1968; Tanaka and Aase, 1987)

Snowfall is an important fraction of the total precipitation falling in the central Great Plains, and residue needs to be managed in order to harvest this valuable resource. Snowfall amounts range from about 16 inches per season in southwest Kansas to 42 inches per season in the Nebraska panhandle. Akron, CO averages 12 snow events per season, with three of those being blizzards. Those 12 snow storms deposit 32 inches of snow with an average water content of 12%, amounting to 3.8 inches of water. Snowfall in this area is extremely efficient at recharging the soil water profile due in large part to the fact that 73% of the water received as snow falls during non-frozen soil conditions.

Standing crop residues increase snow deposition during the overwinter period. Reduction in wind speed within the standing crop residue allows snow to drop out of the moving air stream. The greater silhouette area index (SAI) through which the wind must pass, the greater the snow deposition (SAI = height*diameter*number of stalks per unit ground area). Data from sunflower plots at Akron, CO showed a linear increase in soil water from snow as SAI increased in years with average or above average snowfall and number of blizzards. Typical values of SAI for sunflower stalks (0.03 to 0.05) result in an overwinter soil water increase of about 4 to 5 inches (Fig. 5).

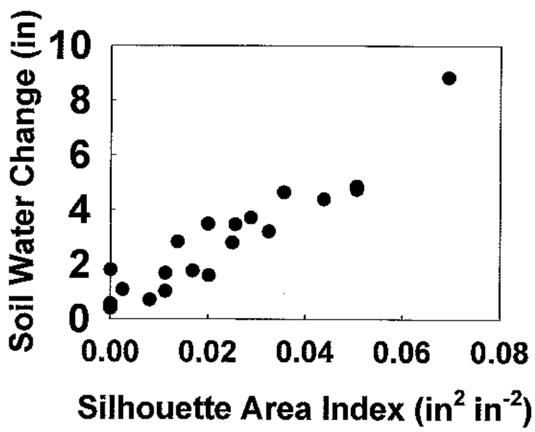

Fig. 5. Influence of sunflower silhouette area index on over-winter soil water change at Akron, CO. (after Nielsen, 1998)

Because crop residues differ in orientation and amount, causing differences in evaporation suppression and snow catch, we see differences in the amount of soil water recharge that occurs (Fig. 6). The 5-year average soil water recharge occurring over the fall, winter, and spring period in a crop rotation experiment at Akron, CO shows 4.6 inches of recharge in no-till wheat residue, and only 2.5 inches of recharge in conventionally tilled wheat residue. Corn residue is nearly as effective as no-till wheat residue in recharging soil water, while millet residue gives results similar to conventionally tilled wheat residue.

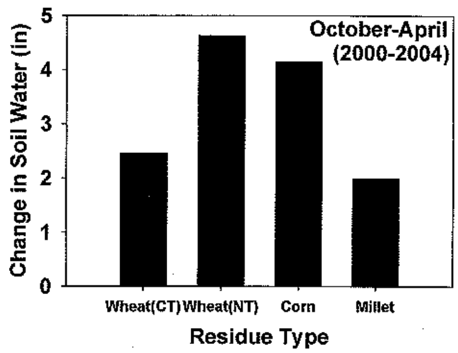

Fig. 6. Change in soil water content due to crop residue type at Akron, CO.

Good residue management through no-till or reduced-till systems will result in increased soil water availability at planting. This additional available water will increase yield in both dryland and limited irrigation systems by reducing level of water stress a plant experiences as it enters the critical reproductive growth stage.

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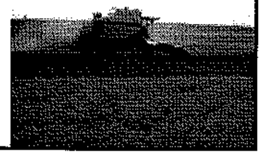
No-till versus Conventional-till Wheat

Brian Olson, Jeanne Falk, Dale Leikam
and many County Agents
in Northwest Kansas



Topics

- 2005 County Comparisons – No-till (NT) versus Conventional-till (CT) Wheat
- Management Decisions
- Wheat Seeding Rate
- Varieties and stripe rust resistance

Objective

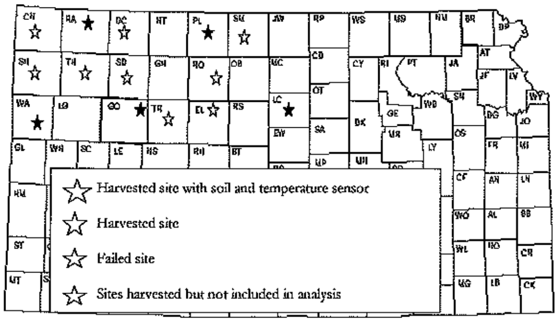
- Background
  - More no-till production on the High Plains
  - Producers would like to move their operation to all no-till
- Can no-till wheat production work across a wide range of environments?
- Are there differences in how wheat varieties respond to different tillage systems?

Methods

- No-till versus conventional-till on area producers fields
- Try to find plots where the field has been in no-till for at least the last two years when the row crops have been growing or longer.
- In May, fields are located for fall planting
  - Systems are maintained throughout the summer
- Plots are planted by K-State faculty at same seeding rate across tillage systems
- Yield is taken at harvest
- Project duration
  - 2003 – a few good sites
  - 2004 – a bust due to dry weather and late freeze
  - 2005 – many sites with good information

Equipment – trailer, pickup, tractor, and drill made possible through a grant from the Kansas Wheat Commission. Thank You

2005 Sites



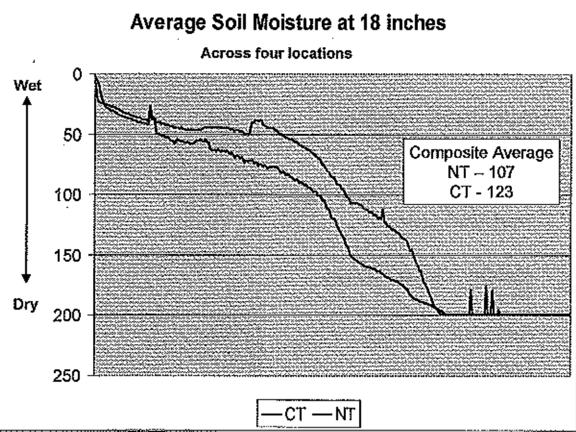
NT vs. CT Results

2005

Variety	Tilla	Thoma	Lincol	Trego	Sherid	Rawlin	Wallac	Decatu	Gove	Philli
Jagger	NT	75.4	42.6	63.0	67.6	47.3	62.2	62.3	73.2	65.1
Jagalen	NT	67.2	40.9	63.6	77.1	47.2	56.9	62.7	81.3	72.4
Cutter	NT	66.7	46.2	51.5	72.1	40.6	61.8	63.7	70.6	65.1
2137	NT	69.1	44.5	51.5	50.8	31.4	41.3	55.1	66.4	50.3
Stanton	NT	64.9	37.0	38.2	59.9	38.8	51.7	59.7	65.3	57.7
T-81	NT	69.5	40.7	56.2	75.6	51.5	54.2	59.4	72.2	62.1
		68.8	**42.0**	**54.0**	**67.2**	**42.8**	**54.7**	**60.5**	**71.5**	**62.1**
Jagger	CT	44.6	39.9	63.4	57.2	48.4	62.7	58.4	62.8	55.2
Jagalen	CT	36.0	39.9	52.5	68.3	48.3	58.2	63.1	68.3	67
Cutter	CT	19.3	35.9	44.9	68.5	51.0	76.0	59.7	64.4	59.6
2137	CT	29.8	40.1	51.1	39.7	36.5	39.7	53.8	54.3	52.1
Stanton	CT	28.3	26.0	36.1	45.8	43.3	41.4	57.2	56.7	53.8
T-81	CT	42.2	30.0	49.0	74.9	45.8	53.5	55.5	69.7	66.9
		33.4	**35.3**	**49.5**	**59.1**	**45.6**	**55.3**	**58.0**	**62.7**	**59.1**

NT vs. CT Results

- 2005 - nine sites
- No-till yielded 58 bu/A
- Conventional-till yielded 51 bu/A
- LSD (0.05) – 4.6 bu/A



Tillage Affect on Varieties

Problem

- Is there a difference on how a wheat variety will yield when grown in the two tillage systems?

Methods

- Four of the sites that were harvested (DC, SD, GO, TR) had 14 varieties planted along with one blend.

Tillage Affect on Varieties

Variety	Bu/A
TAM 111	73.3
Jagalene	67.1
NuHills	66.0
T-81	64.1
Jagger	63.5
Wesley	62.4
Overley	62.0
Cutter	61.9
Dominator	59.5
Jagger/2137/T-81	58.1
Millennium	58.0
Thunderbolt	56.3
2137	52.8
Stanton	52.4
Trego	51.0
LSD (0.05)	9.5

No difference between tillage systems

Conclusions

- In 2005, wheat planted no-till yielded on average 7 bushels higher than wheat planted conventional-till across nine sites in NW KS
- More soil moisture was available for wheat from March to June at the 18 inch depth in no-till when compared to conventional-till
- No difference was observed between tillage systems with respect to wheat performance
- Research not possible with farmer cooperators – THANK YOU

Management Decisions

- Nitrogen
- NITROGEN
- NITROGEN!
- Time
- Seeding Rate
- Variety – preliminary results – no differences
- No-till Drill

Nitrogen Deficiency Symptoms

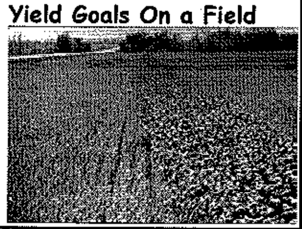
- Pale green - yellow coloration. Starts at leaf tip & down midrib.
- Slow, stunted plant and root development
- Mobile - lower leaves first
- Reduced tillering
- Low Protein

No-Till Wheat, Nitrogen and 2004 ?

- What happened ?

Nitrogen Application Rate

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



Setting A Yield Goal

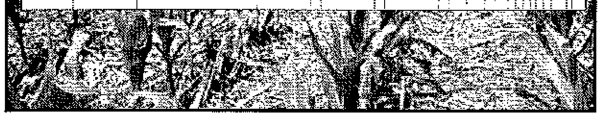
- Set For Individual Fields - Realistic, Yet Progressive
- High Enough To Take Advantage Of Favorable Years - But - Not So High As To Jeopardize Profits/Stewardship
- Appropriate Yield Goals Falls Between Highest Yield Ever Obtained In A Field And 5 Year Average

Preplant Profile N Test

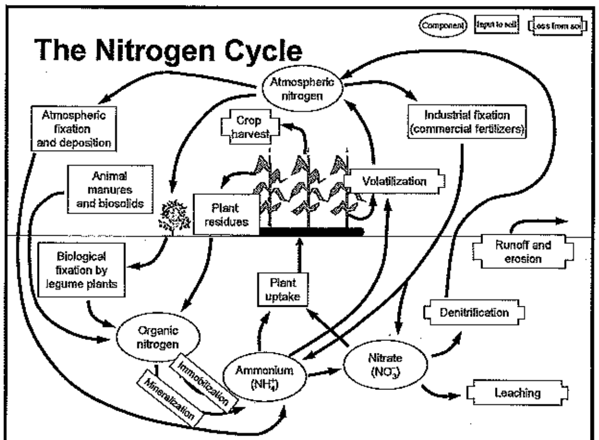
- This is a <u>preplant</u> test - not an in-crop test
- Typically 2 or 3 foot depth
- Commonly used in Great Plains
  - KS, NE, SD, ND, OK, MN*
- Not reliable after fertilizer applied or in growing crop
- Less reliable on sands

N Management in Conservation Tillage Systems

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



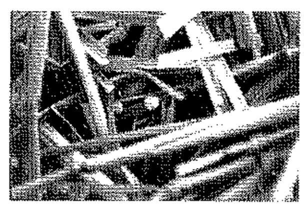
The Nitrogen Cycle



Mineralization Of Organic N From Grain Sorghum Crop Residue

Residue % N	Residue C:N Ratio	Percent Of Residue N Mineralized 110 Days	1097 Days
0.9%	~ 44:1	4.5%	15.7%
1.3%	~ 30:1	9.5%	17.3%
2.1%	~ 20:1	22.3%	29.2%

Vigil, et. al, KSU



Mineralization Of Organic N From Crop Residues

Residue	Residue C:N Ratio	Percent Of Residue N Mineralized In First Year
Grain Sorghum Residue	~ 38:1	12-15%
Wheat Residue	~ 100:1	12-15%

Wagger, et. al, KS

Fertilizer Management

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

New Ideas for Fertilizer

- Topdressing with coulter
  - Injects fertilizer below ground
  - Slices the wheat crown – may cause injury, but jury is still out

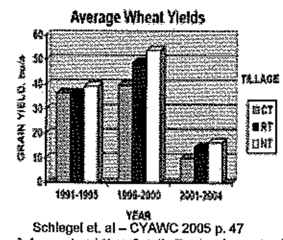
- Exactrix injection system
  - Applies anhydrous ammonia in liquid form at 200 to 400 psi ½ inch from the seed with 10-34-0 and 12-0-0-26.
  - Possible reasons why damage is not occurring to wheat seedling
    - Applying low rates per row
    - Liquid does not have surging problem like anhydrous ammonia in gas form

?????

- New Specialized fertilizer
  - Coated to inhibit volatilization

Time

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



Schlegel et. al – CYAWC 2005 p. 47

Figure 5. Average wheat yields as affected by tillage in a wheat-sorghum-fallow rotation, Tribune, KS

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

Seeding Rate

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

Wheat Seeding Rates

- Jagalene planted at all sites.

Lbs/A	Bu/A
85	56.1
102	55.0
120	54.9
68	52.9
LSD (0.05)	NS

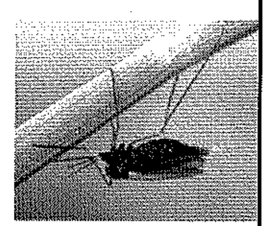
- No seeding rate by tillage interaction
- Wet fall promoted abundant tiller formation that probably masked any possible differences.

No-till Drill

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

Hessian Fly

- What is it ?
  - A small gnat-like fly
- How does it cause damage ?
  - Flies lay eggs on wheat
  - Maggots will hatch from egg and migrate down the wheat leaf to the crown.



- Caution No-till Farmers - Hessian fly infestation has been more pronounced in no-till than conventional-tilled wheat

Skip Row Corn as a Drought Avoidance Strategy

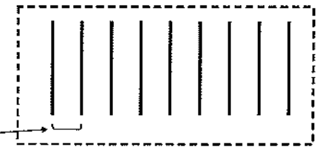
Inspired by Bob Klein North-Platte Nebraska

CGPRS – M.F. Vigil

Conventional planting vs Skip Row Corn

Conventional Planting

30 inches apart

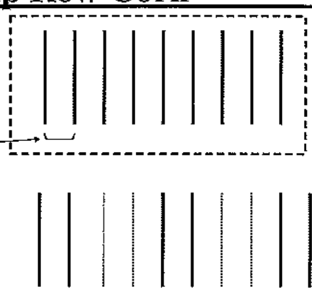


CGPRS – M.F. Vigil

Conventional planting vs Skip Row Corn

Conventional Planting

30 inches apart



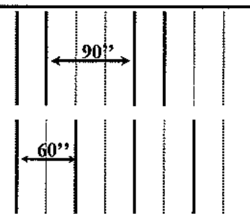
Plant 2 skip 2

CGPRS – M.F. Vigil

Skip Row Corn

Plant 2 skip 2

Plant 1 skip 1



CGPRS – M.F. Vigil

Skip Row Corn

Plant 2 skip 2

12,000 plants/ac

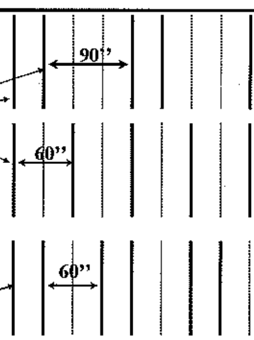
24,000 in the row

Plant 1 skip 1

Plant 2 skip 1

12,000 plants/ac

18,000 in the row



CGPRS – M.F. Vigil

2004 Akron Skip Row Corn Study

Laser-45F3 Cyngenta ~100 day

- Conventional 30 inch rows
- Plant 2 rows, skip 2 rows
- Plant 1 rows, skip 1 row
- Plant 2 rows, skip 1 row

All at 12,000 or 16,000 seeded plant population

Four replications (8 plots per rep), randomized block design, measured grain yield

CGPRS – M.F. Vigil

Skip Row Results

Treatment	population	bu/acre
P2S2	12,000	25 a
P2S2	16,000	23 a

CGPRS – M.F. Vigil

Skip Row Results

Treatment	population	bu/acre
P2S2	12,000	25 a
P2S2	16,000	23 a
P1S1	12,000	22 a
P1S1	16000	21 a

CGPRS – M.F. Vigil

Skip Row Results

Treatment	population	bu/acre
P2S2	12,000	25 a
P2S2	16,000	23 a
P1S1	12,000	22 a
P1S1	16000	21 a
P2S1	12000	19 b
P2S1	16000	17 b

CGPRS – M.F. Vigil

2004 Skip Row Results

Treatment	population	bu/acre
P2S2	12,000	25 a
P2S2	16,000	23 a
P1S1	12,000	22 a
P1S1	16000	21 a
P2S1	12000	19 ab
P2S1	16000	17 b
Conv	12000	16 b
Conv	16000	21 a
LSD (0.05)		7

CGPRS – M.F. Vigil

2005 Akron Skip Row Corn Study

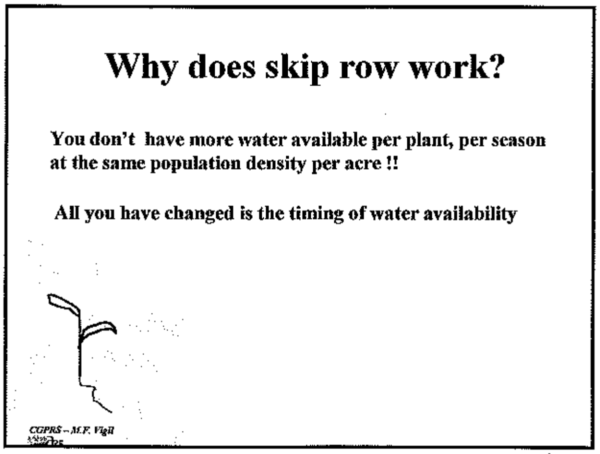
Laser-45F3 Syngenta ~100 day
Conventional 30 inch rows
Plant 2 rows, skip 2 rows
Plant 1 rows, skip 1 row
Plant 2 rows, skip 1 row
All at 11,000 or 13,000 seeded plant population
Added 7,000 plant population for 2005
Four replications (8 plots per rep), randomized block design, measured grain yield

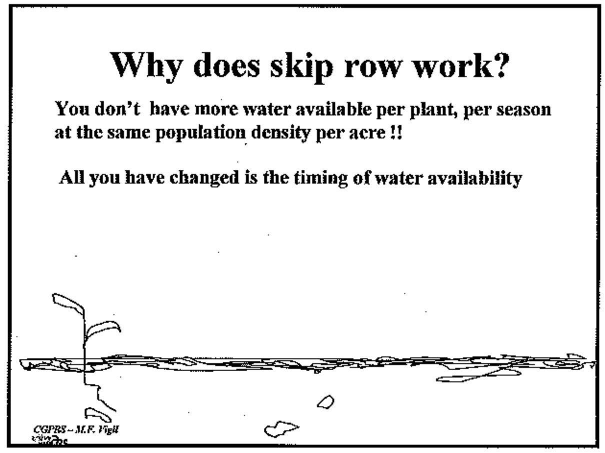
CGPRS – M.F. Vigil

2 year Results bu/acre

Treatment	2004-AK	2005-AK	2005 SC-KS	AVE
P2S2	24	21	61	35
P1S1	22	29	44	31
P2S1	18	23	18	20
Conv	19	16	2	12
P>F	0.21	0.12	0.01	-----

CGPRS – M.F. Vigil


Why does skip row work?
You don't have more water available per plant, per season at the same population density per acre !!
All you have changed is the timing of water availability
CGPRS – M.F. Vigil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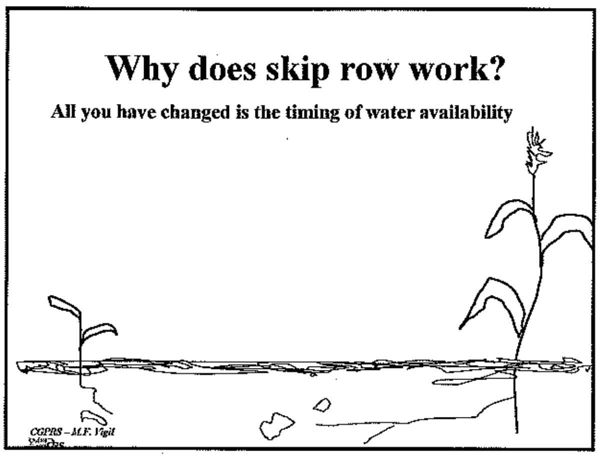
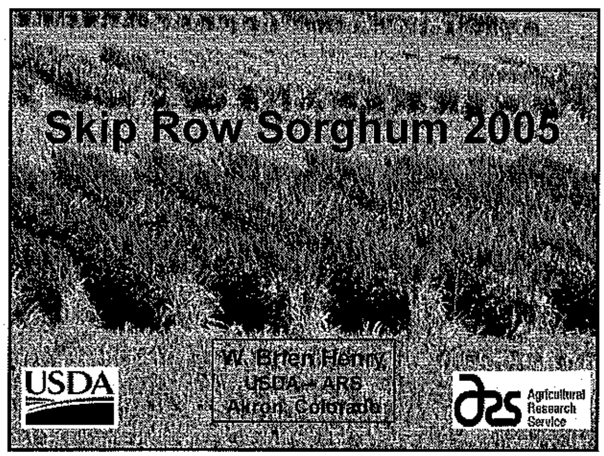
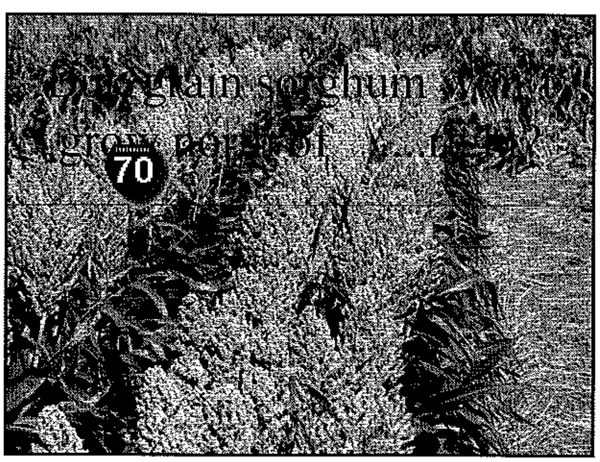
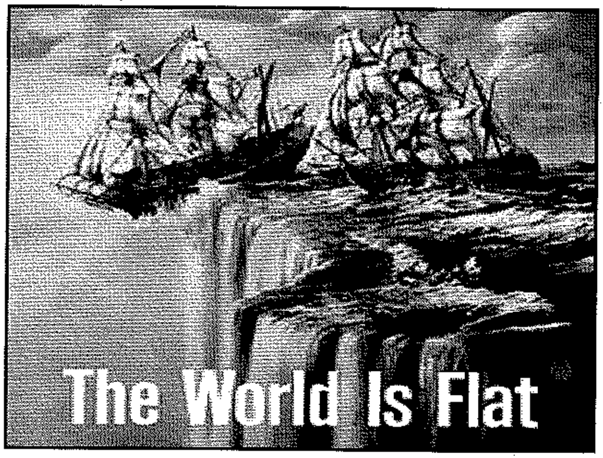
CGPRS – M.F. Vigil

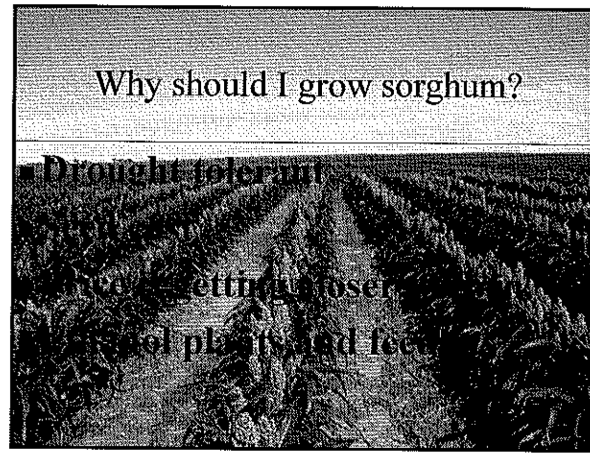

Why does skip row work?
All you have changed is the timing of water availability
CGPRS – M.F. Vigil

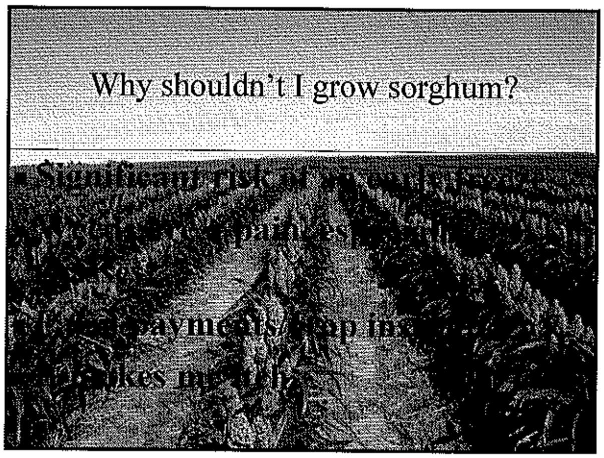

Skip Row Sorghum 2005
W. Brien Henry
USDA – ARS
Akron, Colorado
USDA
Agricultural Research Service


70


Yes it will!!!!!!!!!





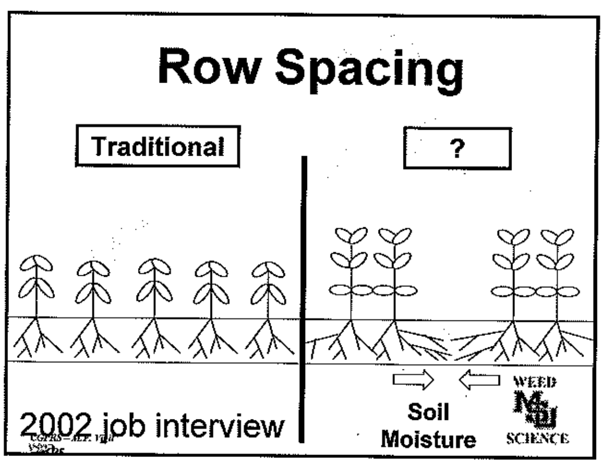


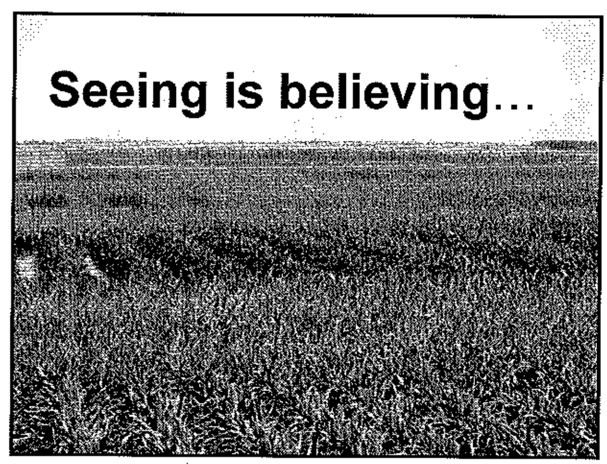
Question #1

How do you plan to use your talents/training/experience as a weed scientist to solve meaningful scientific problems unique to the customers and producers of the Central Great Plains region?

CGPRS – D.C. Nielsen

WEED SCIENCE





Experimental Design

- RCB design with 4 Replications
- May 23 planted DK-28-29, wheat stubble.
- Fertility: 60 lbs N, 4 lb Zn, 9 lb starter N.
- Population (2): 20K and 40K.
- Planting configuration (3): Conventionally, P1 S1 and P2 S2.
- Weed control: **5-4** Glyphosate burndown, **5-27** PRE Bicep with Glyphosate burndown, **6-28** POST Starane + 2,4-D.
- Weather

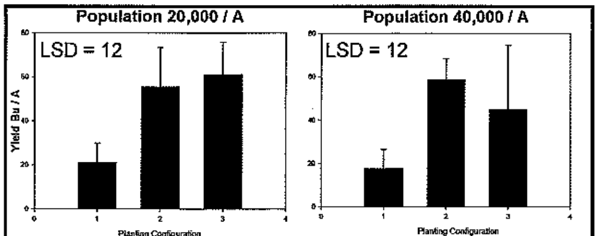
Experimental Design

- Statistical Analysis with standard **ANOVA**
- Planting Configuration **Highly significant**
- ****** p = 0.0001**

Means with the same letter are not significantly different.
LSD = 12.02

t Grouping	Mean	N	Configuration
A	56.99	6	P1 S1
A			
A	52.98	6	P2 S2
B	19.27	6	Conventional

CGPRS-M.F. Vigil



For 2005, 20 bu/A vs. 60 bu/A

Skip row was much better this year.

CGPRS-M.F. Vigil

% Moisture

Least Significant Difference 0.333

Means with the same letter are not significantly different.

t Grouping	Mean	N	Config
A	14.0333	6	P2 S2
A			
A	13.9833	6	P1 S1
A			
A	13.7833	6	Conventional

No significant differences.

CGPRS-M.F. Vigil

Discussion:

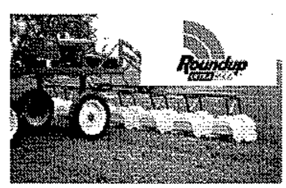
- **Skip row sorghum produced heads 1.5 weeks ahead of conventionally planted.**

- **High population 0.5 sucker/tiller heads vs. 1.5 at the lower population. Seed is cheap.**
- **Consider the conditions this past year.**

Discussion:

- **What about grasses?**

PROWL H_2O herbicide

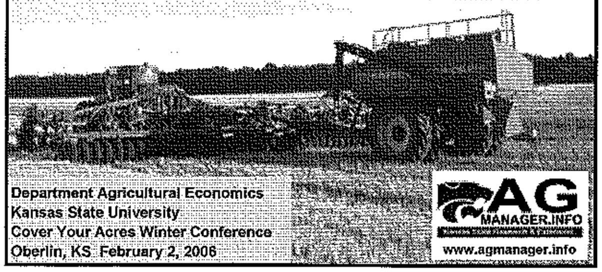


- **Summary**
- **P1 S1 or P2 S2? After one yr of data...**

CGPRS-M.F. Vigil

Economic Impact of No-till and Energy Costs on Land Rental Arrangements

Kevin C. Dhuyvetter – kcd@ksu.edu – 785-532-3527
Troy J. Dumler – tdumler@ksu.edu – 620-275-9164
Terry L. Kastens – tkastens@ksu.edu – 785-532-5866



Department Agricultural Economics
Kansas State University
Cover Your Acres Winter Conference
Oberlin, KS February 2, 2006

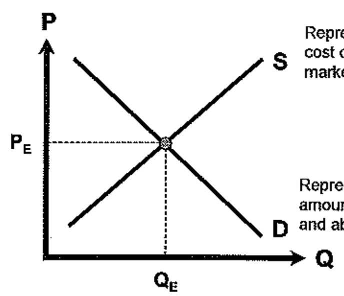
AG MANAGER.INFO
www.agmanager.info

Objective of talk

- Develop an understanding of how technological changes such as no-till, and macroeconomic factors such as energy prices can impact crop leases
- Trying to reduce decisions to numbers
- Decision tools:
  - *KSU-Lease.xls*
  - *KSU-Crop Budgets 2006.xls*
  - *KSU-Landbuy.xls*

2

Market established rental rates ...



3

Market established rates...

- Land Use Value Project of the KSU Ag Econ Dept annually conducts one of four surveys (irrigated, non-irrigated, pasture, input costs)
- Kansas Agricultural Statistics (KAS) annually surveys landowners and producers regarding land values and cash rents
- Local and regional surveys of leasing practices
- With surveys there is often a trade-off between statistical validity and level of aggregation

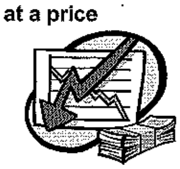
---

Problem:

The market equilibrium prices we observe (when they are available) often do not reflect individual situations.

That is, they reflect averages, but nobody is average...

... so what can we do to arrive at a price that reflects an equilibrium?



Way to find acceptable lease rates (crop shares and cash rents) ...

While landowners and tenants (i.e., the market) ultimately determine terms of crop share and cash leases, we use the *equitable* concept to arrive at a starting point for negotiations.

6

A good crop share lease should follow five basic principles ...

1. Yield increasing inputs should be shared
2. Share arrangements should be adjusted as technology changes
3. Total returns divided in same proportion as resources contributed

---

4. Compensation for unused long-term investments at termination
5. Good landlord/tenant communications

7

Principle #1:
Yield increasing inputs should be shared

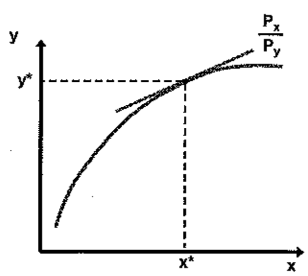
The reason it is recommended that yield increasing inputs should be shared is this provides the economic signal for the economic optimal amount of the input to be used.

8

Principle #1:
Yield increasing inputs should be shared

Examples of yield increasing inputs

- Fertilizer
- Irrigation water
- Herbicides ???
- Seed ???



9

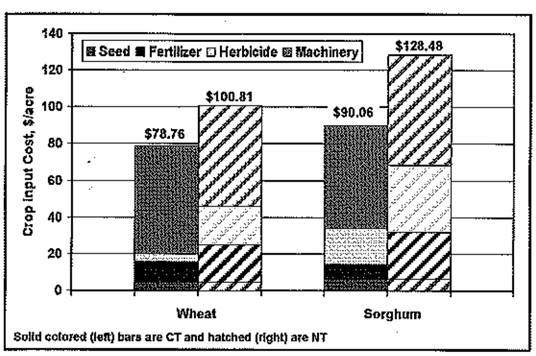
Principle #2:
Technology may affect share arrangements

Examples of technological change

- Reduced-/no-till
- New crops and/or rotations
- Center pivot irrigation
- Hybrid seed
- Bio-technology
- Precision agriculture (GPS)

10

Tribune WSF Crop Input Costs



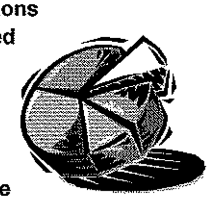
Costs for wheat and sorghum increase 28% and 40%, respectively with NT.

11

Principle #3:
Returns divided in same proportion as resources contributed.

This requires annual contributions of both parties to be identified (budgeting type approach).

Valuing inputs can depend on whether the lease being developed is a one-year lease versus multiple-year lease.



12

Lease Examples of WF and WCF
(based on 2005 Farm Management Guides)

Equitable Crop Shares with Wheat-Fallow vs. Wheat-Corn-Fallow Rotations

Contributor — (L=Landlord, T=Tenant, and S=Shared (equitably)

Alternative Arrangements for Sharing Various Inputs

Crop Rotation	Wheat-Fallow			Wheat-Corn-Fallow			
Land	L	L	L	L	L	L	L
Machinery	T	T	T	T	T	T	T
Fertilizer[1]	S	S	T	S	S	S	T
Herbicide (wheat)[1]	T	S	T	T	T	S	T
Herbicide (corn)[1]	—	—	—	T	S	S	T
Other	T	T	T	T	T	T	T
Contributions (L/T)	35.1/64.9	37.5/62.5	30.1/69.9	27.1/72.9	30.5/69.5	31.7/68.3	21.7/78.3
Net return, $/ac	-$25.14	-$25.14	-$25.14	-$15.11	-$15.11	-$15.11	-$15.11

[1] Application costs not included (accounted for in "Other").

13

Lease Examples of WF and WSF
(based on 2005 Farm Management Guides)

Equitable Crop Shares with Wheat-Fallow vs. Wheat-Sorghum-Fallow Rotations

Contributor — (L=Landlord, T=Tenant, and S=Shared (equitably)

Alternative Arrangements for Sharing Various Inputs

Crop Rotation	Wheat-Fallow			Wheat-Sorghum-Fallow			
Land	L	L	L	L	L	L	L
Machinery	T	T	T	T	T	T	T
Fertilizer[1]	S	S	T	S	S	S	T
Herbicide (wheat)[1]	T	S	T	T	T	S	T
Herbicide (corn)[1]	—	—	—	T	S	S	T
Other	T	T	T	T	T	T	T
Contributions (L/T)	35.1/64.9	37.5/62.5	30.1/69.9	29.2/70.8	33.1/66.9	34.5/65.5	23.3/76.7
Net return, $/ac	-$25.14	-$25.14	-$25.14	-$17.42	-$17.42	-$17.42	-$17.42

[1] Application costs not included (accounted for in "Other").

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Principle #4:
Compensation for unused long-term investments at lease termination.

It is generally recommended that landowners make long-term investments such as terraces, irrigation well, lime, alfalfa seed, etc.

If the tenant pays for long-term investments, or shares their cost, he should be compensated for his share of any value that remains when the lease is terminated

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Principle #5:
Good communications between the landlord and the tenant.

Because so many of the terms of a lease are based on negotiation between the landowner and the tenant, good communications are critical.

A lease is a legal contract in Kansas, thus it is suggested that terms of the lease agreed upon by both parties be put in writing. This becomes more important as the complexity of leases increases.

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Impact of high energy prices on leases

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Historical and forecasted diesel prices during principal farming months...

Diesel Prices

Year	Mar-Oct Diesel Price SW KS	US (EIA)	Average	Year-to-year percent change SW KS	US (EIA)	Average
2000	$1.09	$1.04	$1.07	—	—	—
2001	$1.09	$0.98	$1.04	0.6%	-6.1%	-2.7%
2002	$0.94	$0.88	$0.91	-14.1%	-10.0%	-12.1%
2003	$1.05	$1.05	$1.05	12.1%	18.6%	15.3%
2004	$1.37	$1.34	$1.36	30.0%	28.4%	29.2%
2005	$2.04	$2.02	$2.03	48.5%	49.9%	49.2%
2006 (F)	$2.04	$2.10	$2.07	0.3%	4.1%	2.2%
05 - Avg(00-04)	$0.93	$0.96	$0.94	83.5%	90.2%	86.8%
06 - Avg(00-04)	$0.93	$1.04	$0.98	84.0%	97.9%	90.6%

F = forecast

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Estimated effect diesel price has on machinery costs per acre based on custom rates...

Fuel Consumption and Diesel Price Impact for Various Field Operations

Operation	Custom rate*	$0.04	$0.50	$0.71	$0.75	$1.00
		Fuel price increase, $/gallon				
		Increase in custom rate, $/acre				
Chiseling	$7.96	$0.03	$0.42	$0.60	$0.63	$0.85
Field cultivation	$6.27	$0.03	$0.33	$0.47	$0.50	$0.67
Disking	$6.84	$0.03	$0.36	$0.52	$0.54	$0.73
Min-till planter	$10.29	$0.04	$0.55	$0.78	$0.82	$1.09
No-till drill	$10.72	$0.05	$0.57	$0.81	$0.85	$1.14
Sprayer	$4.03	$0.02	$0.21	$0.30	$0.32	$0.43
Swather-conditioner	$8.90	$0.04	$0.47	$0.67	$0.71	$0.94
Round baler	$8.03	$0.03	$0.43	$0.61	$0.64	$0.85
Combine–wheat	$14.48	$0.06	$0.77	$1.09	$1.15	$1.54
Combine–soybeans	$20.06	$0.09	$1.06	$1.51	$1.60	$2.13
Combine–corn	$20.09	$0.09	$1.07	$1.51	$1.60	$2.13

* 2004 state average reported by Kansas Agricultural Statistics

Increase from 2004 = $0.71/gallon, increase from 2000-04 average = $0.98/gallon.

Increase in custom rate	0.4%	5.3%	7.5%	8.0%	10.6%

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Historical and forecasted natural gas prices during principal farming months...

Natural Gas Prices

Year	Mar-Oct Natural Gas Price NYMEX	US (EIA)	Average	Year-to-year percent change NYMEX	US (EIA)	Average
2000	$4.04	$3.85	$3.95	—	—	—
2001	$3.69	$3.49	$3.59	-8.6%	-9.3%	-9.0%
2002	$3.35	$3.12	$3.23	-9.2%	-10.7%	-10.0%
2003	$5.35	$5.24	$5.30	59.5%	68.2%	63.7%
2004	$5.99	$5.63	$5.81	11.9%	7.5%	9.7%
2005	$8.77	$8.37	$8.57	46.5%	48.6%	47.5%
2006 (F)	$9.19	$8.65	$8.92	4.8%	3.3%	4.1%
05 - Avg(00-04)	$4.28	$4.11	$4.20	95.5%	96.3%	95.9%
06 - Avg(00-04)	$4.70	$4.39	$4.55	104.9%	102.9%	103.9%

F = forecast

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Historical and forecasted fertilizer prices during principal fertilizing months...

Fertilizer Prices (Corn Belt)

Year	NH3 (82%)	UAN (32%)	Urea (46%)	- P -	- K -	Wtd Avg	Year-to-year % change
Percent of total	40.0%	17.5%	17.5%	20.0%	5.0%	100.0%	
			Oct-May Fertilizer Price*				
2000	0.136	0.204	0.205	0.211	0.148	0.175	—
2001	0.217	0.305	0.272	0.193	0.148	0.234	33.2%
2002	0.141	0.218	0.187	0.201	0.144	0.175	-25.3%
2003	0.195	0.253	0.227	0.209	0.141	0.211	20.7%
2004	0.218	0.290	0.262	0.214	0.141	0.234	10.8%
2005	0.238	0.356	0.322	0.223	0.174	0.267	14.4%
2006 (F)	0.309	0.440	0.351	0.228	0.194	0.318	18.8%
05 – Avg(00-04)	$0.057	$0.103	$0.092	$0.017	$0.029	$0.061	29.9%
06 - Avg(00-04)	$0.128	$0.186	$0.120	$0.023	$0.050	$0.112	54.4%

* Oct-Dec of previous year (P = average of 10-34-0 and 18-46-0, K = muriate of potash)
F = forecast

06 vs Avg(00-04)	170.4%	173.3%	152.2%	111.2%	134.5%	154.4%

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Impact of high costs on leases ...

KSU-Lease.xls is a tool that can be used to analyze the impact of current costs have on equitable crop share leases as well as their cash-rent equivalents

The impact high costs have on leases will depend on each specific situation due to how producers change (or not change) production practices in response to these high prices

➔ producers should "run their own numbers"

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Sources of data ...

- **Crop budgets are designed to follow KSU Farm Management Guides and thus these budgets are often a good "first start" at inputs**
- **Machinery costs are based on custom rates approach (as opposed to investment per acre)**
- **Generally suggest using "average" data as opposed to farm-specific data, but this will depend on situation**

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Dryland example assumptions ...

- **75% of land cropped annually (58.3% wheat and 41.7% milo) with other 25% fallow**
- **Equitably share all fertilizer on both crops (tenant pays application costs)**
- **Equitably share herbicide and application costs on milo**
- **Initial analysis is based on fuel and fertilizer costs at 2000-04 averages**
- **Examined impact on equitable crop share and cash rent equivalent with increased costs (all else held constant)**

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Dryland example summary* ...

	Equitable share	Cash rent	Profit
Base scenario	66.2 / 33.8	$29.98	-$2.99
Increased fertilizer costs	66.2 / 33.8	$25.40	-$13.36
Increased fuel costs	67.6 / 32.4	$28.04	-$7.47
Increased fuel and fert costs	67.6 / 32.4	$23.50	-$17.84

* Based on fertilizer and fuel price forecasts on 12/1/05

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Irrigated example assumptions ...

- Rotation -- 67% corn and 33% soybeans
- Equitably share fertilizer, herbicides, insecticides, and irrigation energy (tenant pays application costs on fertilizer, shared on others)
- Tenant owns center pivot and motor, landowner owns well, pump and gearhead (tenant pays 75% of irrigation repairs, landowner 25%)
- Initial analysis is based on fuel and fertilizer costs at 2000-04 averages
- Examined impact on equitable crop share and cash rent equivalent with increased costs (all else held constant)

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Irrigated example summary* ...

	Equitable share	Cash rent	Profit
Base scenario	74.9 / 25.1	$62.41	-$18.95
Increased fertilizer costs	74.9 / 25.1	$51.64	-$44.94
Increased pumping costs	74.9 / 25.1	$37.16	-$79.89
Increased fuel costs	75.6 / 24.4	$58.87	-$27.64
Increased costs (ALL)	75.6 / 24.4	$23.03	-$114.56

* Based on fertilizer, natural gas, and fuel price forecasts on 12/1/05

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Summary ...

High input prices will have significant impact on crop returns in 2006

High diesel fuel prices will impact returns, but they have relatively minor impact on equitable crop share percentages

Crop share tenants will not be impacted nearly as much as those cash renting (assuming fertilizer and irrigation pumping expenses are being shared)

Producers cash renting need to negotiate with landowners to see if they will help "share the pain" (likewise for crop share tenants not sharing fertilizer or irrigation pumping costs)

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Summary ...

Producers need to "do their homework" to make sure they understand the numbers before talking to their landowner(s)

Tenants need to think long-term when negotiating with landowners

-- Impact of losing or giving up land?

-- Have "good times" been shared?

Good landlord/tenant communications will be critical as we go through these tough economic times

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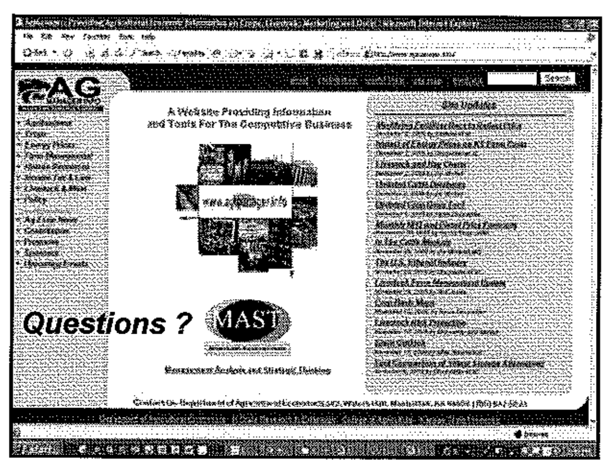


Wildlife Enhancement & Rodent Control in No-till
Cover Your Acres

Charles Lee
Extension Wildlife Specialist
Kansas State University

Rodents in Croplands

Rodents are small mammals belonging to the order Rodentia. Most of them weigh less than 3.5 oz. Most rodents are squat, compact mammals with short limbs and a tail. They can be distinguished from other mammals by: (1) a pair of chisel-like front teeth, called incisors, (2) lack of canine teeth, (3) a few molars on each side of the jaw, and (4) a toothless gap between the incisors and cheek teeth. The incisors continue to grow during the lifetime, but are worn down by gnawing.

Rodents are quite intelligent and can master simple tasks when conditioned. They have an acute sense of hearing, smell, taste and touch. Rodents are highly social animals and use many of their senses to communicate. Their behavior is highly adaptable. Most rodents have high rate of reproduction. Most species commonly have 6-12 young in each litter and a female of some species can have one litter each month. Because of their high reproductive rates and ability to invade many habitats, rodents are able to spread and multiply quickly. Populations, however, may soon crash because of predation, disease and food shortages.

Rodents are important not only because they may be pests in cropfields but some species may also be threatened or endangered and deserve legal protection. The species I most often hear complaints about in Kansas are not threatened or endangered! Rodents do serve as an important prey base for animals higher on the food chain such as owls and other raptors, coyotes, badgers, and others. Some species such as the beaver and muskrat are economically important as well.

Field reports and research from Kansas have identified several rodents as causing economic loss in croplands. Species involved include the deer mouse (*Peromyscus maniculatus*), cotton rat (*Sigmoddon hispidus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), prairie vole (*Microtus orchrogaster*), Ord's kangaroo rat (*Dipodomys ordii*), and pocket gopher (*Geomys bursarius*).

Investigations of small mammals in croplands have focused on two questions: 1) What effects do populations of small mammals have on the crop? 2) What are the best techniques to control the damage?

Damage prevention and control methods include exclusion, habitat modification, frightening, repellents, toxicants, fumigants, trapping, and shooting. Technique effectiveness differs by rodent species, crop being affected and the time of the year. Repellents and frightening techniques are generally not effective for rodent control.

Suitability of Techniques to Control Rodents Damaging Cropland.

	Exclusion	Habitat Modification	Toxicants	Fumigants	Trapping
Deer mice	NE[1]	Rotate crop	Anticoagulants 2% Zinc phosphide	NR[2]	Intense effort needed
Cotton rat	NE	Remove dense vegetation	2% Zinc phosphide	NP[3]	Intense effort needed
Ground squirrel	Works but not cost effective	Allow tall rank vegetation or lots of ground litter	2% Zinc phosphide	Aluminum phosphide Gas cartridges	Snap traps or glue boards
Prairie vole	Effective in orchards on individual trees	Eliminate ground cover Cultivation	Anticoagulants 2% Zinc phosphide	NE	Intense effort needed
Kangaroo rat	Small areas of high value crops	Encourage dense stands of rangeland grass near crop borders	2% Zinc phosphide	Aluminum phosphide Gas cartridges	Snap traps or cage traps
Pocket gopher	Annual tillage on borders of hayfields	Damage resistant varieties. Flood irrigation Crop rotation	Anticoagulants 2% Zinc phosphide Strychnine	Aluminum phosphide Gas cartridges	Gopher kill traps

[1]NE- Not Effective

[2]NR-None Registered

[3]NP- Not Practical

Generally rodents impact crop yields by preventing adequate plant densities to ensure a good yield. They seldom damage mature crops.

Wildlife Enhancements:

Management for wildlife can provide several benefits to landowners. Abundant wildlife populations and natural areas provide recreational opportunities, such as bird watching, fishing and hunting. Management practices for improving wildlife habitat often provide ecological benefits such as reduced soil erosion, higher water quality, and increased soil moisture. Some wildlife habitat improvements (like windbreaks) can reduce costs of home energy, cattle feed and equipment fuel. Creating habitat for bats and certain birds that consume insects might reduce the need for costly insecticides. Some landowners can receive additional income by establishing private or public wildlife recreation preserves on their land. In addition, many habitats intended to protect wildlife can serve as outdoor classrooms for children, who can learn to identify plants and animals as well as learn how human and environmental needs can be balanced.

If you want to manage your cropland in a way that is sensitive to wildlife needs, you first need to decide which wildlife species you want to attract. For example, are you interested in game species (like deer) or grassland birds? Each wildlife species has different habitat requirements. All wildlife need four basic habitat components to survive: food, water, shelter, and space. Food and water are necessary for nourishment. Shelter is needed for protection against weather and predators. Space is essential for activities such as gathering food, attracting mates and raising young. Each wildlife species requires a unique blend of these elements. Then determine which factors are limiting the growth of the targeted wildlife species. Contact your local wildlife biologist wildlife biologist for assistance if necessary. Wildlife enhancements are designed to nullify those limiting factors.

One of the problems facing small game and non-game wildlife species in Kansas today is the lack of suitable nesting, brood rearing and winter cover. We have the best chance of being successful in increasing wildlife populations by incorporating changes in croplands since they cover a majority of the state. Many wildlife species that once thrived in farmland settings are now experiencing long term population declines in association with intensified agricultural land use, herbicide and pesticide use, and large-scale mechanized farming. Years ago harvested crop fields provided essential wildlife cover and food. Now after harvest, grain fields provide very little wildlife benefit due to the lack of vertical cover or crop residue. Several practices can be implemented on any crop field to provide usable wildlife habitat, while at the same time improving soil and water quality.

Some view wildlife habitat enhancement negatively because they may believe it takes potential money-making crop acreage away from the landowner. This may not be the case at all. Many wildlife habitat enhancement practices on cropland can be implemented without reducing crop yield or idling ground. However many conservation programs authorized by the Farm Bill are federal and state cost-share programs targeted at idling cropland. Some programs pay land rental payments for as many as 15 years at reasonable rates.

Conservation Tillage

Conservation tillage is a broad term that refers to several tillage methods that maintain crop residue on the field surface during the fall and winter months. This is an excellent practice for increasing wildlife habitat. By allowing crop residue to remain in the field, you reduce soil erosion, maintain soil moisture, increase organic matter, and provide wildlife forage. In contrast, if you plow or disk in the fall, you create essentially barren land for wildlife and increase the potential for soil erosion. Such action also increases costs due to nutrient loss and increased fertilization needs. Fields disked in fall usually have to be tilled again in the spring as well due to soil compaction over the winter.

Farmers in the wheat/fallow region of Kansas, could benefit financially by implementing a practice known as delayed minimum tillage (DMT). This system selects wheat varieties that produce taller plants, harvests wheat to allow the tallest stubble (think stripper headers), avoids herbicide use post-harvest, replaces spring tillage with a non-selective herbicide and then uses an undercutter for weed control after mid-summer and if necessary a disk for final seedbed preparation. Implementing this type system permits most nests to survive and maintains anchored, upright residue when it's is most needed for fallow soil moisture storage. From 1996- 2001 the DMT system provided the highest net return per acre ($39.05), when compared to no-till ($30.37), and conventional tillage ($2.95) at the KSU Research and Extension Center at Tribune, Kansas.

Crop Rotation

Crop rotation simply means planting different crops in the same field over successive years. Long-term rotation may include planting 3 or 4 different crops before returning to the same crop in a given field. Best results can be obtained by incorporating a legume (plant that adds nitrogen to the soil), such as soybeans, into the rotation. By rotating crops, you reduce the risk of crop disease, insect problems, and fertilizer requirements. Small grain crops, such as wheat and oats, should be incorporated into the rotation to provide nesting cover throughout the spring and early summer. Fallow fielding is another excellent way to allow the land to rest while creating wildlife cover. Fallow fields are crop fields that are taken out of rotation for one or more years. While fallow, the fields are simply allowed to grow up in natural vegetation. Although this vegetation may look like weeds, it provides important seeds, bugs, and cover for wildlife. Crop rotation that includes fallow fields will provide increased diversity within any given area.

Field Edges

Field edges next to trees or riparian areas represent an opportunity to develop excellent wildlife habitat at minimal cost. They are often shaded and may not produce enough crop to justify harvesting. Try to leave the outside 4 or 5 rows of crops unharvested for wildlife. This is an easy way to develop long, linear annual grain food plots. Ideally, these strips should be left adjacent to brushy escape cover. If possible, leave them fallow for 2 to 3 years for nesting and brood-rearing cover. This can easily be achieved by alternating sides of the field left standing in crop. Let the strips sit idle and allow native vegetation to grow within the standing crop residue.

It is also possible to establish grasses around the edges of crop fields, either as field borders (strips of grass around the perimeter of crop fields) or filter strips (field borders adjacent to rivers, creeks, and streams). Native warm season grasses are ideal, although certain cool season grasses with legumes incorporated can also be beneficial. Not only will this practice produce wildlife habitat, but native warm season grass also provides an excellent source of summer hay. Riparian buffers, which consist of trees, shrubs, and grasses, are another option for managing streamsides and wetland habitat. Start your riparian buffer next to the body of water or wetland by planting trees, followed by a transitional zone of shrubs, and ending with a strip of grasses. The widths will vary and should be set by site-specific goals and needs.

Grassed Waterways

Shallow waterways running through crop fields should be planted to grass to prevent soil erosion, filter runoff water, and enhance wildlife habitat. In Kansas, they are often planted to brome. Although brome will provide excellent erosion control and water filtration, it is not of much value to wildlife due to its thick, matted sod and poor upright structure during the winter. If possible plant waterways, or convert existing waterways that are primarily brome to wildlife-friendly grasses. Options include a variety of native warm season grasses such as big bluestem, little bluestem, switchgrass, Indiangrass, eastern gammagrass and forbs such as Illinois bundleflower, Maximillian Sunflower, Purple prairie clover, Partridge pea (showy) and Upright prairie coneflower.

Terraces & Contour Buffers

Terraces are steps built across the slope of a field to intercept runoff water and reduce soil erosion. They are often sloped towards a waterway or wooded draw to handle the runoff water. Usually, they are planted to grasses. Again, native warm season grasses would be an excellent choice.

Contour buffer strips are suitable for crop fields with steep slopes. Contour buffer strips work just as their name implies. Simply follow the contour of the slope and establish wildlife-friendly perennial grasses. These strips slow water runoff, reduce soil erosion, and trap sediment, nutrients, and pesticides. The strips should alternate with wider strips of crop. The width of the alternating strips should be determined based on slope and soil type.

Fencerows

Shrubby fencerows around crop fields are very important areas for wildlife. They are often viewed negatively due to their appearance and the fact that they break up potentially larger fields into smaller units that are somewhat less efficient to farm. However, by the same token, they provide critical travel corridors and escape cover for wildlife as well as natural windbreaks that reduce soil erosion. Ideally, fencerows should be 50 to 100 feet wide and encompass transition zones on each side. The first zone should be shrubs, and next would be a strip of grasses on the outside. Again this is the ideal fencerow; not everyone is willing to develop such a fencerow. Narrower fencerows provide similar values and are also very important. By simply allowing grasses and forbs to grow up along and around old fences, you can enhance habitat for wildlife. All fencerows are valuable and need to be enhanced and not destroyed.

Food Plots

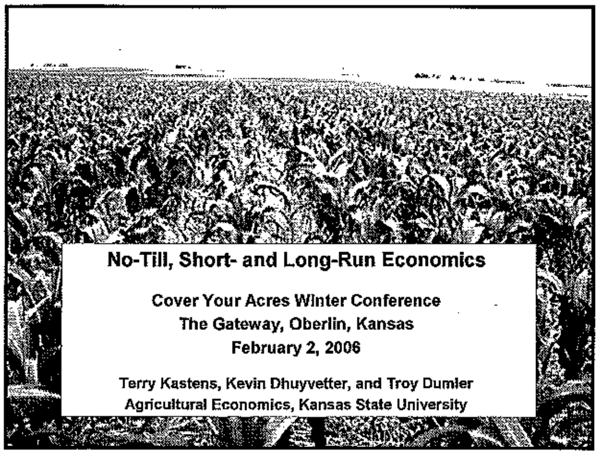
Food plots provide winter food for wildlife. Leave 10-12 rows of unharvested, standing crop along the entire length of field edges (especially sides that adjoin fencerows, woodland or rangeland). Corn is the most common forage plant for wildlife, but milo, millet and or a mixture of all three are more beneficial. During harsh winters and low acorn production years, turkeys and deer will use corn heavily. Twelve 50-foot rows of standing corn will support 20 turkeys for 3 months. Perennial crops such as clover, alfalfa and other legumes can be planted to provide food for pheasants, quail, turkeys, songbirds, rabbits and deer in the summer. Of course, maintaining food plots may increase wildlife damage to nearby row crops, so carefully consider your primary objectives. Food plots are not important if brood rearing cover is the limiting factor. Lack of suitable reproductive areas which include nesting and brood rearing cover is usually what limits pheasants and quail numbers in Kansas.

Water

Water is sometimes a limiting factor for wildlife in cropland systems. Several types of water-related practices can be implemented to benefit wildlife. Some of the more common practices include shallow water wetlands and small, shallow ponds. A good source of year around water can improve wildlife use in any given area. If you have large areas without accessible water, you should consider adding a wildlife watering pond or guzzler. Shallow water areas are greatly beneficial to amphibians. Ideally, water sources should be available within one-half mile of any point on a farm, or distributed about one per 100 acres.

Key Points to Remember

- **Use native plant species** when replacing cropland with permanent vegetation. Native plants generally provide the best food and cover for wildlife.
- **Bigger is better.** Because little natural habitat remains in some areas of rural Kansas, providing as much natural area (permanent cover) as possible is best.
- **Connect natural areas** via hedgerows or buffer strips or patches of natural vegetation. Natural areas that are connected to one another allow animals to disperse and move between areas.
- **Food plots may be important.** During extended periods of severe winter and deep snow, food plots may make it easier for birds to survive, but also make it easier for predators including hunters to find the birds.



No-Till, Short- and Long-Run Economics

Cover Your Acres Winter Conference
The Gateway, Oberlin, Kansas
February 2, 2006

Terry Kastens, Kevin Dhuyvetter, and Troy Dumler
Agricultural Economics, Kansas State University

No-till (NT) is a technology to consider

Potential benefits . . .

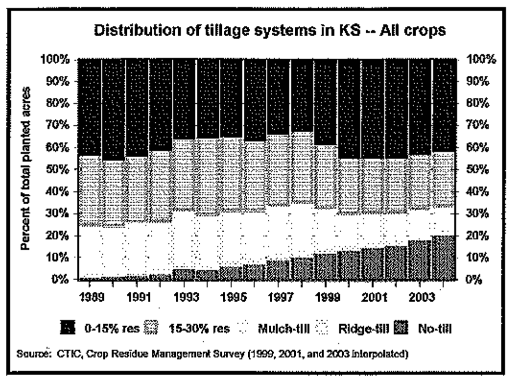
- Machinery cost savings
  - Reduces fuel and labor requirements
- Allows farm expansion
  - Dilutes fixed costs (spread over more land)
- May improve timing
  - Reduces land preparation time
  - Can increase cropping intensity
- Related to water savings
  - Can increase cropping intensity
  - Increases crop yields

2

Speed of technology adoption depends on

- Size of the expected profit
- Confidence in the outcome
- Investment amount required
- Keep in mind . . .
  - Late adopters adopt for survival
  - Early adopters adopt for profit
  - Speed of adoption is important only relative to your neighbors

3



Most growth in no-till has come at expense of mulch-till

4

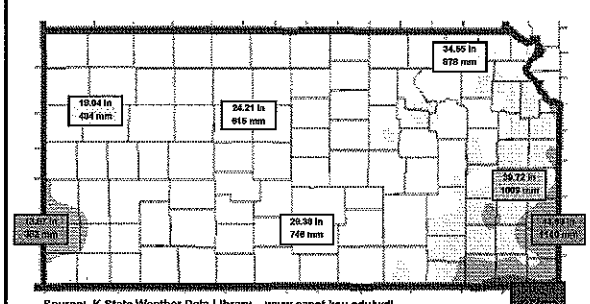
Profitability ...

Revenue (yield x price)
- Cost (variable and fixed)
Profit or net returns

Tillage won't impact price, thus profitability will depend on how yields and costs are affected by reducing tillage.

START WITH YIELDS . . .

Kansas Annual Precipitation, 1971-2000



Source: K-State Weather Data Library -- www.oznet.ksu.edu/wdl

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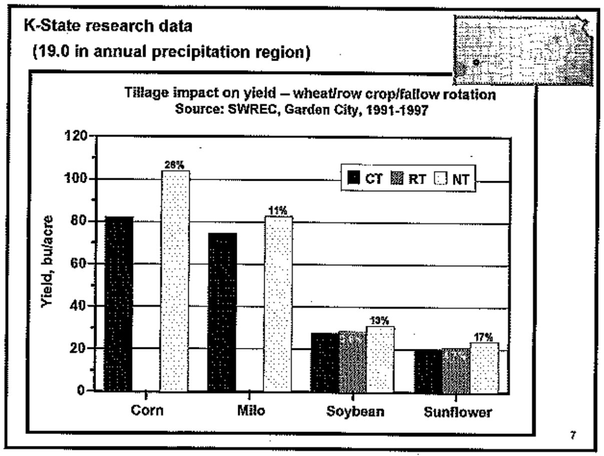
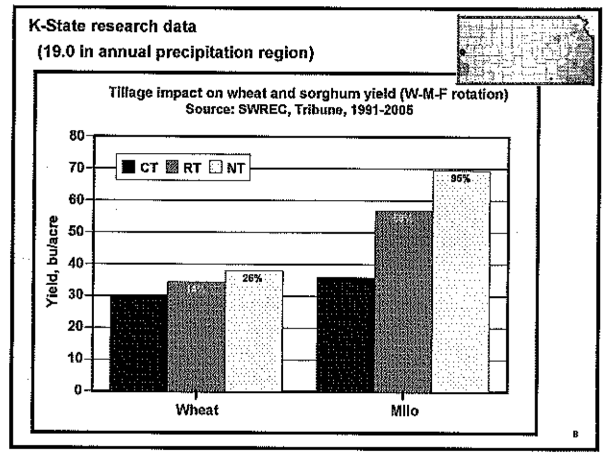
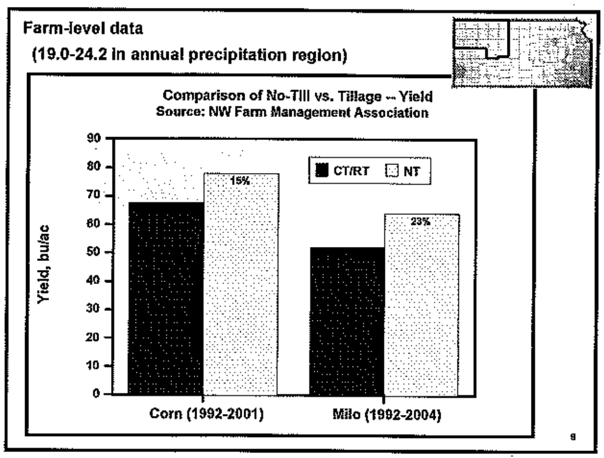
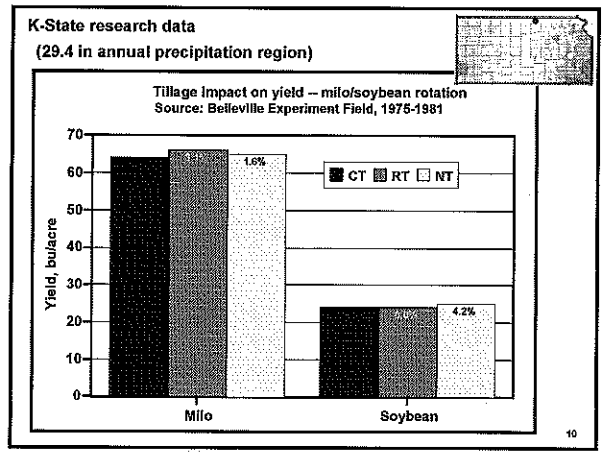
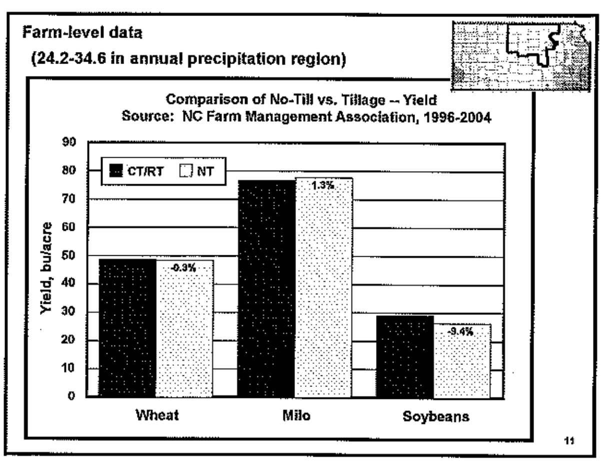










Effect of tillage on yields?

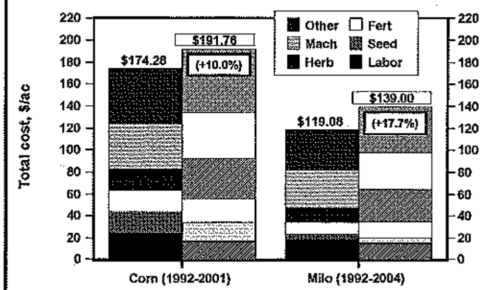
Research in central and eastern Kansas generally has shown little yield difference between tillage systems for wheat, milo, soybeans, and corn => NT cost driven.

Research in western Kansas has shown that yields increase as tillage is reduced, especially for summer crops such as corn and milo => NT revenue driven.

AND NOW A LOOK AT COSTS . . .

Actual farm-level data

Comparison of No-Till vs. Tillage -- Costs
Source: NW Farm Management Association



Solid colored (left) bars are CT/RT and hatched (right) bars are NT

Higher yields allow adoption of this more costly technology

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Actual farm-level data

No-Till cost study - NC Farm Management Association, 1996-2004

	$/land acre		$/harvested acre	
EXPENSE ITEM, $/acre	CT/RT	NT	CT/RT	NT
Direct input (seed, fert, chem, etc)	$41.26	$55.41	$42.04	$53.37
Machinery cost	$39.44	$35.60	$40.24	$34.27
Labor	$28.35	$24.42	$28.95	$23.50
Total asset charge	$38.59	$38.03	$39.38	$36.63
Building and conservation	$2.99	$2.09	$3.06	$2.01
Other	$11.94	$9.09	$12.18	$8.75
Total expense	$162.58	$164.63	$165.84	$158.53
Total acres	938	1,212	908	1,256
Harvested acres/land acres	xxxxx	xxxxx	96.8%	103.6%

NT farms are cropping more intensively

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Effect of no-till on costs

- Central and eastern KS data indicate slight decrease to little change in total costs if acreage is held constant. Western KS data suggest costs increase with NT compared to CT.
- Changes cost "structure" — i.e., herbicide is substituted for tillage-related expenses.
- Fixed costs (land, machinery, management, etc.) will depend on acreage and thus will vary between producers.

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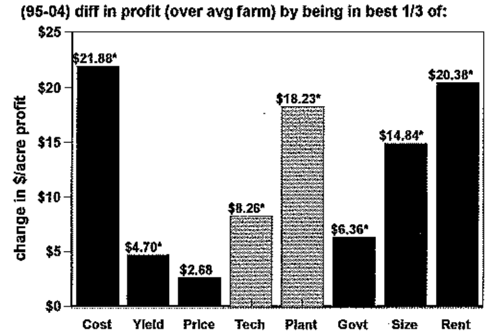
No-till affects profits ...

(95-04) diff in profit (over avg farm) by being in best 1/3 of:



* statistically different from 0 at 90% confidence

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SUMMARY

- No-till is increasing in all areas of Kansas
  - Cost is the main driver in central and eastern KS (lower cost => higher net returns)
  - Revenue is the primary driver in western KS (higher revenue and higher cost)
- Producers "ahead of their neighbors" at adopting less tillage have had higher profits
- Management efforts – focus on being low cost, technology adoption, and production (planting intensity, yield)

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Water drives NT in the High Plains

- Water in soil at planting often as important as rainfall during growing season
- Questions are now emerging:
  - Tillage or chemicals during fallow period before wheat (referred to as chem-fallow)?
  - Intensify cropping beyond 2 crops in 3 years?
  - Follow a rotation or change crops based on available soil water at planting?

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Continuous-crop long-term NT questions

- How fast does SOM build over time?
  - How deep in the soil are changes observed?
  - Why should I care about SOM?
- Does soil structure change?
- Many crops in rotation or few?
- Will NT rotations in one area work in other areas?
- Do soil changes impact yields, input costs, or profits?

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Changes with continued NT

- Fast changes
  - Surface crop residue: improves water infiltration and reduces evaporation
  - Wheat stubble height especially important
- Medium changes
  - Soil structure (pore size) and strength:
    - Holds more water and water travels through faster
    - Surface doesn't seal off as fast during a rainstorm
    - Can support wheel traffic better
- Slow changes
  - SOM:
    - Indicator of positive change
    - Provider of mineralized crop nutrients (N & P)
    - Improves P solubility and availability

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Residue: changes near the soil surface

- Get more rain in the soil and keep it there for plants
  - Crop residue improves water infiltration
  - Crop residue reduces evaporation
  - High wheat stubble better than short stubble, especially in low yielding situations
    - Akron field trial:
      - 4 inch stubble: evaporation is 80%
      - 12 inch stubble: evaporation is 50%
      - 20 inch stubble: evaporation is 38%
    - Tribune field trial (2001-2004):
      - Leaving about 13 inches rather than 6.5 inches resulted in 8.2 bu/acre increased yield for the following corn or milo crop

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NT-caused long-term changes in soils

- Changes will NOT be deep in soil
  - Increased capacity of water storage not large
- Slow changes in SOM over time
  - Savings in fertilizer due to mineralization will eventually matter, but not for a long time and not as important as water savings
- But, small changes near the soil surface can be especially important in drier areas
  - It's all about getting more water in soil and retaining it
  - More water will be observed in NT soils than in CT soils, even through whole rooting zone

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Tribune Kansas Research

- Over 31 years (1974-2004), differences in available soil water (ASW) & rainfall explain:
  - 61% of differences in wheat yield
  - 58% of differences in milo yield
- A 15-year (1991-2005) wheat-milo-fallow (WMF) study compared CT to RT to NT for:
  - available soil water (ASW)
  - grain yields
  - water use efficiency (WUE)

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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

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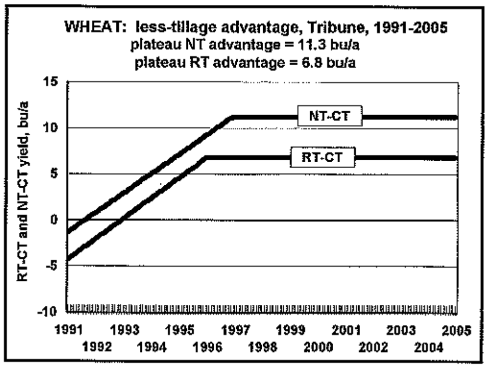

NT-over-RT: 4.5 bu/a (HUGE in this 35 bu/a environment)

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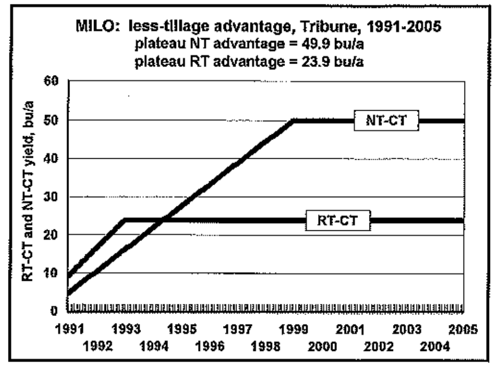
Difference in lines is benefit to chem-fallow



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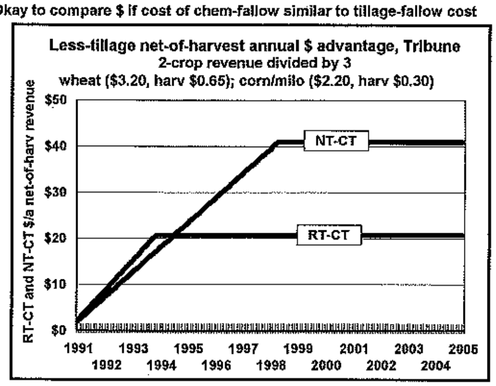
Okay to compare $ if cost of chem-fallow similar to tillage-fallow cost



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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**

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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 5-6 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* 26 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"

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Questions ???

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Auto Steer for Farm Machinery and GPS Guidance Systems

Randy Taylor
Extension Ag Engineer, Machinery Systems
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With the increasing availability of GPS receivers and changes in farming practices the popularity of GPS guidance systems is rising. Furthermore, the availability of free differential correction signals such as WAAS and Coast Guard Beacon, over a wider area has increased the number of lower priced DGPS receivers. As well, the increase in reduced and no-till acres has increased the importance of crop protection application and created challenges for producers to follow their desired path in the field. Crop stubble creates an environment where seeing the previous pass can be difficult. Several manufacturers have introduced GPS guidance systems to address these challenges and the market continues expanding. GPS guidance systems rely on a satellite signal to determine the vehicle's location and indicate to the operator where he should be driving. Systems range from those that display a desired path to the operator via rows of lights or an image to ones that automatically steer the vehicle.

Why GPS Guidance?

GPS guidance systems are intended to increase productivity by minimizing overlap and skips. Improving steering accuracy could potentially reduce crop inputs such as chemicals, fertilizers and seed, as well as other inputs such as fuel and time. Guidance systems also allow producers to operate in conditions that have historically been challenging. They can be used to extend operational hours for tillage, spraying, or planting while not increasing operator fatigue. In some cases a GPS guidance system can replace traditional marker systems such as foam or planter markers, while sometimes they are used to supplement traditional markers. Either way they can help improve driving accuracy in low visibility conditions such as night, dust, fog, or no-till stubble. An often overlooked use for a guidance system is to count rows when operating in a growing row crops. As you enter the turn rows at the end of the field and make your turn, the guidance system will lock onto the next swath to help you locate your next path through the field, thus eliminating the tedious task of counting rows.

GPS Accuracy

GPS accuracy, mounting, and tilt compensation should be understood when discussing GPS guidance systems. Performance of a GPS receiver can be considered in two ways, accuracy and precision. Accuracy is defined by how well the receiver can locate itself on the face of the earth. This is more important when you want the capability to return to an exact location at some time in the future. Precision is determined by the consistency or repeatability of the receiver. Precision for GPS guidance systems is typically reported in terms of pass-to-pass error. A more precise system will have a lower pass-to-pass error. It is possible to be precise without being accurate.

Position Accuracy

There are no standard procedures or tests for measuring dynamic (moving) GPS accuracy, so GPS accuracy is typically reported for static (not moving) conditions. However, static accuracy can be defined with multiple terms so it can be confusing to consumers. Though static accuracy may not be a good indicator of dynamic accuracy, most sub meter GPS receivers can be fairly precise for short periods. This short term precision aids guidance system performance. Manufacturers typically advertise dynamic accuracy by stating expected pass-to-pass performance.

Several recent studies have attempted to evaluate dynamic accuracy of current GPS technology. Though there is some variability in the results, DGPS receivers commonly used for guidance have pass-to-pass errors less than 10 inches. Some receivers have pass-to-pass errors less than 4 inches.

In general, guidance systems can be broken into three categories based on GPS accuracy. A real time kinematic (RTK) GPS system is the most precise and accurate. These systems offer sub-inch pass-to-pass precision and very repeatable accuracy. These systems are the most expensive and require a base station. Multiple vehicles can use a signal from the same base station as long as they are within range of the radio signal. Operation requires line of sight so typical ranges of operation will vary with terrain, but are usually less than 6-8 miles. It is possible to set up repeater stations to extend the range of the radio signal. Since multiple vehicles can operate with the same base station, the cost of RTK systems can be spread over many users. There have even been RTK networks set up that cover many miles. These networks allow users to have RTK accuracy with wide area DGPS mobility.

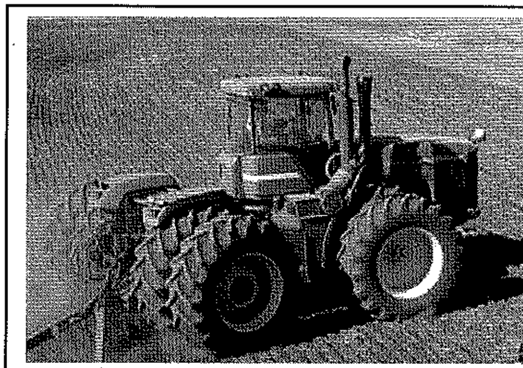
The second category contains receivers capable of providing pass-to-pass accuracy less than 4 inches. These are dual frequency DGPS receivers that require a subscription signal for differential correction. The cost of the signal varies with provider. Since there is no base station, these systems have a wider range of operation. Though the pass-to-pass precision is good, they are not as accurate or repeatable as RTK systems. However, advances in differential correction techniques are improving the accuracy of dual frequency receivers and these receivers can now be used for tasks that previously required RTK systems.

The third category offers pass-to-pass precision of about 8-10 inches. These are typically powered by GPS receivers that are using a single frequency differential correction from a subscription provider or the FAA's Wide Area Augmentation System (WAAS).

GPS Mounting Location

There are many locations to mount GPS receivers on tractors, combines and sprayers. First, the receiver should be mounted on the centerline of the vehicle since this is the target line for steering. Manufacturers typically recommend that the receiver be mounted at the highest point on the machine. Mounting the receiver on the front of the cab, or grain bin extension on a combine, is typically the best location because it will give the receiver the best, unobstructed view of the sky. This will allow the receiver to get signals from as many satellites as possible and potentially reduce error. Another mounting dimension to consider is the fore/aft position of the receiver. In general, this is not a huge consideration but it bears some thought. Some manufacturers recommend mounting the receiver over the front axle of 2WD tractors. They reason that this is where the steering occurs and will be the location that is most sensitive to steering changes. It is also closer to the ground and less affected by vehicle roll. With articulating 4WD tractors, the front of the cab is typically close to the pivot point. Mounting the receiver close to the pivot point will make it less sensitive to steering changes. Mounting the receiver further from the pivot point will cause it to move off center more when subtle steering occurs. Some users have mounted the GPS receiver on the front of the hood and report more that the steering system is more responsive. The fore/aft mounting of the GPS receiver is probably not a huge concern for driver steered systems. It may not be an issue if the settings for auto steer systems are correct.

The GPS receiver is typically mounted at the highest point on the vehicle to get a clear view of the sky.



Mounting the GPS receiver on the front of the hood for articulating tractors, makes it more sensitive to steering changes and less sensitive to vehicle roll.

Tilt Compensation

Mounting the GPS antenna on the cab of a tractor or sprayer puts it 9-10 feet above the ground. This could possibly create problems when operating on slopes. As long as slope is consistent, there won't be much problem since the receiver will always be indicating downhill. However, antenna height becomes a problem when the slope is changing. For example, a pass is made on relatively level ground near a terrace and the next pass is made on the back for the terrace where there is more slope. The location of a GPS antenna relative to the center of the tread will be different for these two passes. The difference will depend on the antenna height and slope. This is inherent to all systems, unless they correct for vehicle tilt, and the user should be aware of the operational characteristic.

Inertial sensors are used to detect sudden vehicle movement such as pitch and roll. More importantly, yaw sensors are typically used to supplement the GPS signal for steering corrections. Inertial sensors update at rates that are 5-10 times faster than GPS and improve the reliability of predicting a vehicles path. The yaw sensor can detect sudden changes in steering direction and help stabilize steering corrections for automatic steering systems.

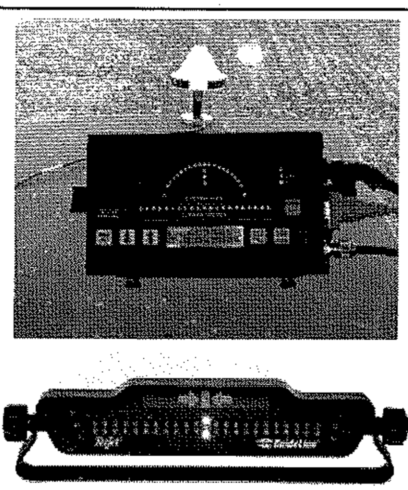
At least one guidance system uses a GPS array, multiple GPS receivers mounted on a single platform, to determine vehicle dynamics. The relative signals among the receivers are used to determine pitch, roll, and yaw.

Types of Systems

Guidance systems come in two basic categories: operator steering and assisted or automatic steering. Manual steering systems use a GPS receiver and display to indicate a desired path for the operator. The operator's task is to interpret the display and make steering corrections to follow the desired path. The operator is in full control of steering at all times. Assisted steering systems provide 'hands free' operation when on the desired path. The operator will turn the vehicle at the end of the row and line up on the desired path. Once on the path, the operator presses a resume button, similar to a cruise control on a car, and the steering control system takes over. The operator can disengage the steering control system at any time by turning the steering wheel.

Operator Steering

With an operator steered system, GPS accuracy is irrelevant if the operator cannot interpret the signal and make timely steering corrections. The operator must be able to easily and quickly respond to the signal from the guidance system without being distracted by the display. After some practice, operators can generally 'see' the display without looking directly at it. There are two basic types of operator interfaces for guidance systems. One uses an array of lights and the other uses an image. There are different configurations of each type and multiple ways to configure some units. Operators should find one that is easy to configure and interpret.



Light based systems indicate the vehicle's position relative to the intended path and the direction the operator should steer to return to the path.

Light based systems use lights to indicate what the operator should do to maintain the desired path. Image based guidance systems use an image of the vehicle and an indication of where the vehicle should be relative to the desired path. Some may also incorporate audible commands for the operator.

Image based systems may be more visually appealing, but also may be more of a distraction to the operator. These systems typically show a line or 'road' that the vehicle should follow. They also show the vehicle's location relative to the desired path. In some cases, the visual display will also show the area of the field that has been previously covered by 'painting' it. As agricultural electronics continue to evolve, these displays will serve multiple functions. While determining which display type is the most effective would be a challenging research project, operators can typically determine which one they prefer quickly.

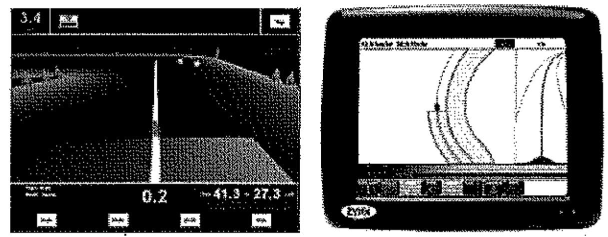


Image based systems indicate the vehicle's position and show the intended path as a road or line.

In addition to display considerations, some thought should be given to the accuracy of the GPS receiver used for operator steered systems. An operator probably cannot make steering corrections that result in pass-to-pass accuracy less than 6-8 inches over an extended time period. Therefore, purchasing a GPS receiver that is more accurate than this is probably 'overkill.' While a dual frequency receiver may be alright on an operator steered system, RTK should be reserved for auto steering systems.

Assisted or Automatic Steering

Automatic steering for agricultural tractors, sprayers, and combines has been accomplished with GPS systems. Auto steering systems frees the operator to do a better job of monitoring equipment functions and reduces overall stress associated with steering a vehicle for long periods. An auto steer system may improve steering performance, but it is not a substitute for an inexperienced operator. Having an operator with knowledge of machine performance is still important when using an auto steering system.

Initially auto steer systems used highly accurate and precise real-time kinematic (RTK) GPS systems. However in the last few years, systems using less accurate GPS receivers have been introduced. The pass-to-pass precision of these less accurate systems is adequate for many field operations, but they may not be able to return to the same exact spot at some point in the future.

The key item to consider when selecting an automatic steer system is accuracy of the GPS system. For example, RTK guidance may be more than you need for typical field tillage or maybe even spraying. However, the RTK system may be exactly what you need for planting row crops or strip tillage. Other features to consider are ease of use and the operator interface. The best thing to do is take a test drive before you purchase a system.

Features and Abilities

The most common, and simplest, feature of most guidance systems is straight line guidance. The operator drives and logs a reference pass and the parallel passes of a preset swath width are created. The operator logs the reference pass by recording an A point at the beginning of the pass and a B point at the end. Each time the operator turns; the guidance system finds a new pass and indicates a steering pattern to follow this pass. In the straight guidance mode, all subsequent passes are typically referenced to the initial A-B line. The reference pass is typically place in a location that is easily driven in a straight line. This could be along a fence line or road. Straight line guidance can be conducted in back and forth or racetrack patterns.

Contour guidance is a feature of most systems. This feature allows the operator to drive a curved pass. At the end of the first pass, the guidance system creates a new pass parallel to the initial pass. Each subsequent pass is typically created parallel to the previous pass and not the initial pass. Though contour guidance may be a feature, it should be noted that it can be difficult to use especially in the absence of other peripheral information such as terraces and other land features.

Most guidance systems also provide the ability to mark points in the field. This may be a location where application was stopped and you want to return to the point to resume. However, it may be difficult to use this feature if the system just indicates the distance and direction. The operator may not be able to take the most direct route and thus must learn how to use the information to find the point using another route.

Compatibility with Other Devices

GPS guidance systems come in many shapes and forms and though they may initially be purchased for guidance only, they have many other potential uses. The GPS portion of the guidance system can often be used to provide position information for yield monitors, controllers, or computers. The GPS for a guidance system should provide the necessary flexibility to communicate with these other devices. This means the capability of providing a standard NMEA (National Marine Electronic Association) string output, usually a $GPGGA and $GPVTG string. The GGA string contains position and signal quality information while the VTG string primarily contains speed information. These communication protocols have become agriculture industry standards. Newer GPS receivers have the ability to communicate with a Controller Area Network (CAN), which is quickly becoming standard on all new agricultural vehicles. The CAN bus allows easy, reliable communication from all standard CAN devices regardless of manufacturer.

Selection Criteria

Select a GPS guidance system that meets your needs. Operator steered systems should be easy to use and interpret. You may want the ability to quickly transfer these systems between vehicles. The differential signal should provide adequate pass-to-pass accuracy for the intended tasks. You may not want a more accurate system today, but don't rule out that possibility for the future. Consider the potential for upgrading to a more accurate differential signal or even auto steering. The GPS guidance you select should offer you the ability to improve without starting over.

Consider the potential of integrating the guidance system into a control system. This control system may include interfacing with application controllers for fertilizers and/or chemicals. Features to consider are real-time coverage maps that show where product has been applied while you are in the field. Another feature worth investigating is automatic boom section control. These systems will automatically turn off boom sections in areas that have already been sprayed.

Residue Grazing

Ron Hale
SW Area Livestock Specialist

High Feeding Costs

- Over-feeding nutrients
- Extended hay feeding
- Too much dependence on concentrate feeds
- Too little use of forages for winter feeding
  - Stockpiled or growing

Crop Residues

- Less expensive than other forages
- Can supply much of cow's needs
  - Dry, first 2/3 pregnancy
- Grazing is not detrimental to subsequent crops
- ½ - 1 acre / cow
  - One acre corn "=" 900 lbs hay

Residue Nutrients

	Corn	Sorghum
Leaves		
%	57%	44%
DM	87.5	87.3
CP	5.13	8.17
ADF	49.7	45.1
NDF	77.0	64.4
TDN	49.0	53.3
Stem		
%	43%	56%
DM	88.9	68.3
CP	4.14	4.43
ADF	50.67	50.3
NDF	79.1	72.1
TDN	44.1	49.1

Bled et al., 1999

Corn Residue Comparisons

Three Published Nutrient Lists

Nutrient	1	2	3
TDN, %	50	59	66
NEm, Mcal/lb	.44	.59	.68
Crude protein, %	5.9	5.0	6.5
Calcium, %	.57	.35	.62
Phosphorous, %	.10	.19	.09

Corn Residue Comparisons

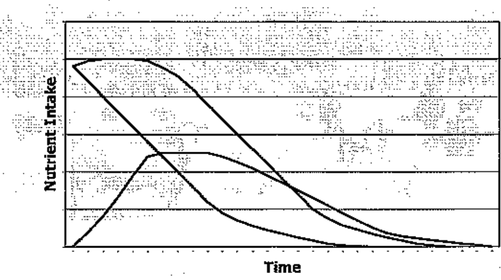
Grant County Corn Fields
Fall 2003

Field	Grain bu/acre	Forage tons/acre
1	1.1	4.5
2	0.7	4.2
3	8.5	4.5
4	0.5	5.1

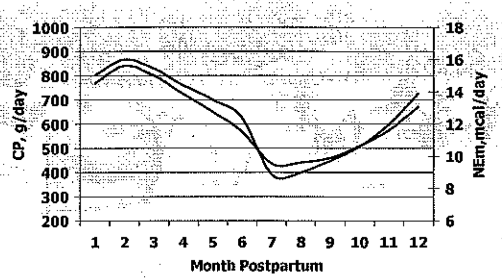
Crop Residues

- Highest nutrient content early
  - Grain
  - Leaves & husks
  - Stalks
- Crude protein
- TDN
  - 70 → 40%
  - Increased stocking rate causes faster decrease

Nutrient Potential



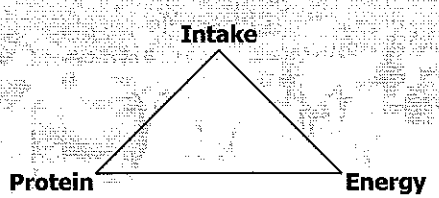
Cow Requirements



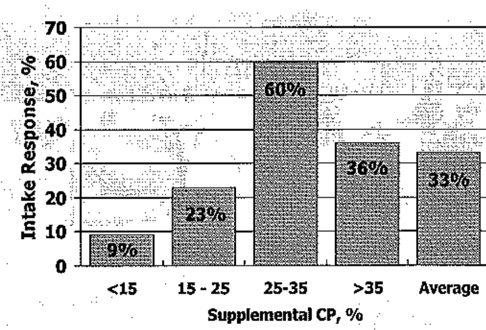
Cow Requirements

	Mid gestation	Late gestation	Post calving
		Crude protein	
%	7.0	8.0	9.5
Lbs	1.4	1.7	2.1
		TDN	
%	49	54	56
Lbs	9.5	11.2	12.1

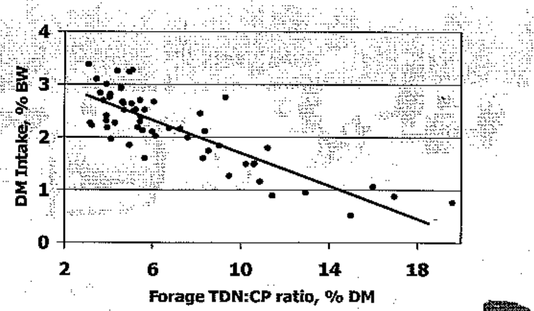
Relationships



CP and Forage Intake

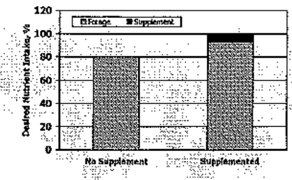


CP, TDN and Forage Intake



Forage Quality Limiting-Availability Not Limiting

- Improve performance by increasing forage utilization



- Crude protein content is low
- Feed small amount of CP supplement to improve digestion and stimulate intake
  - >30% CP from all natural source
  - 50-60% rumen degradable CP
  - 0.1-0.3% BW
  - Daily, 2 or 3 days weekly

Supplemental Needs

- All dead or dormant forages
  - Salt
  - Calcium
  - Phosphorous
  - Vitamin A
- Protein and/or energy
  - Natural protein is better
  - Level depends on age and stage of reproduction
  - Depends on residue

Grazing Strategies

- Whole field grazing
- Strip/controlled grazing
- Spring or fall calving
- Graze by nutritional requirement
- Wheat as the supplement

Limited Wheat Grazing

Four hours wheat grazing twice a week

- 2 days of wheat pasture
  - 10.0 lb/d Wheat X 25% CP = 5.0 lb
  - 8.0 lb/d stalks X 5% CP = .8 lb
- 5 days of residues
  - 24 lb/d X 5% CP = 6.0 lb CP
- 11.8 lb CP / 7 days = 1.7 lb CP/day

Dry Cows

November December	1 day (4 hrs) - winter cereals 5 days – dry grass / stalks
January February	1 day (4 hrs) - winter cereals 4 days – dry grass / stalks
March	1 day (4 hrs) - winter cereals 3 days – dry grass / stalks
150 days grazing	32 days – winter cereals 118 days – dry grass / stalks

Elder, 1967

Limited Grazing - Cows

- Spring Calving Cows in mid to late gestation
  - Fence off adjacent corn or milo stalks
  - Graze wheat 4 hrs every third or fourth day (2 X/week)
  - Improve condition of thin cows prior to calving
  - Replacement heifers, 1st calf heifers
- Fall Calving Cows and Calves
  - Lactating cows: Graze for 4 hrs. every other day
  - Unlimited access for calves via creep gates
  - Creep gates improved calf wts ~ 75 lb
  - Limited grazing for cows improved calf weights 25 - 30 lb

Harvesting Residues

- Increased costs
- Decreased weather related problems
- Typically lower nutrient level
- Potentially less waste
- Pen feed – manure
- Ammoniation best for <5% CP & <45% TDN

Evaluating Forage Opportunities

- Know production costs
- Inventory forage resources
- Describe nutrient content on calendar basis
- Describe cow's need on calendar basis
- Define marketing objectives
- Develop grazing & management plans based on sound information
- Grazing & management plans must fit available resources
- Pregnancy & weaning rates must be maintained at relatively high level for profitability
- Make changes slowly
- Make sure changes & systems fit your resources

Adams, 200

Livestock Effects of Grazing Crop Residues on Soil Bulk Density[1]

R. K. Taylor[2] and J. W. Slocombe[3]

Soil bulk density was measured at two sites with respect to livestock grazing treatments (grazed and ungrazed). These samples were taken at depths of 0-3 inches and 3-6 inches. There was no statistical difference ($p>0.01$) between bulk density for the two treatments at the 3-6 inch depth for either site. However the grazing treatment had significantly greater ($p<0.01$) bulk density than the ungrazed treatment at the 0-3 inch depth at both sites.

Introduction

Grazing livestock on crop residues can be potentially valuable to livestock producers. The impact of livestock on soil properties can affect subsequent crops planted in fields that have been grazed. After studying the influence of livestock trampling under rotational grazing systems on soil hydrologic characteristics in Texas, Warren et. al (1986) concluded a significant reduction in water infiltration rate and significant increase in sediment production occurred with a silty clay surface devoid of vegetation. They also reported soil physical properties such as bulk density, aggregate stability, and aggregate size distribution, were related to the soil hydrologic responses to the treatment.

Solie et. al (1993) studied the influence of soil compaction by animals winter grazing hard red winter wheat. Their three year study was conducted to determine if soil compaction from grazing stocker cattle affected wheat production (forage and grain) and evaluate the effectiveness of tillage practices in relieving soil compaction from previous crops as a growth inhibitor. They concluded cattle grazing late fall and winter were associated with surface soil compaction with soil bulk densities greater than 1.5 g/cm^3 and soil cone penetrometer readings greater than 290 psi 2-4.8 inches below the soil surface at planting the following year. Additionally, they concluded this compaction can be associated with wheat forage and grain yield reductions in the following year's crop. The objective of this study was to evaluate the effects of stocker cattle grazing grain sorghum stalks on soil bulk density.

Procedures

This study was conducted on two fields in central Kansas; one in Rice County (near Lyons) and one in Smith County (near Smith Center). The Rice county field consisted primarily of Crete silt loam and Smolan silty clay loam and was planted to grain sorghum in the spring of 1998 and harvested in late October. The stocker cattle on this field had access to approximately 75 acres of winter wheat pasture as well as the grain sorghum stalks. The Smith County field consisted of Harney silt loam and was planted to grain sorghum in the spring of 1998 and harvested in early November. Stocking rates and duration of grazing for each of the two fields are shown in Table 1.

To facilitate a comparative soil bulk density analysis between grazed and ungrazed soil, three sixteen foot livestock panels were erected to form a triangle (110 ft^2) at five randomly selected locations in each field before the fields were stocked. At the conclusion of the grazing period, soil bulk density samples were taken at the five locations in each field prior to tillage in the spring of 1999. A slide hammer double ring 3 inch diameter core sampler was used to take five samples each from the grazed and ungrazed (protected by the livestock panels) areas at each location in the field. Each sample was divided between depths of 0-3 inches and 3-6 inches. This resulted in 100 samples per site. The soil samples were transported to the laboratory, weighed, oven dried @ 100° C for 24 hours, then weighed again to determine bulk density.

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[1] K-State Forages Task Force Project. The authors appreciate the cooperation of Todd Whitney, former CEA Rice County, Sandra Wick, CEA, Smith County, Knight Feedlot, Lyons, KS and Gary Gerstenkorn, Smith Center, KS.

[2] Department of Biosystems and Agricultural Engineering, Oklahoma State University

[3] Department of Biological and Agricultural Engineering, Kansas State University

Results

Soil bulk density and water content for grazed and ungrazed treatments are shown in Table 2 by depth. Bulk density was greater for the grazed treatment at both depths in both fields. The magnitude of variation was significant ($p<0.01$) at the 0-3 inch depth and not significant at the 3-6 inch depth. The higher bulk density indicates a more compacted soil. Soils with a higher bulk density have less pore space for air and water to occupy. The higher water content in the ungrazed treatment is also evidence of this. Comparatively, water content was greater at both depths in the ungrazed treatment. The water content differences were significant ($p<0.01$) at the 0-3 inch depth for both sites and significant ($p<0.01$) at the 3-6 inch depth at Rice County.

Conclusions

These results suggest compaction by livestock was confined to the 0-3 inch depth as was the depleted water content. Compaction in this zone is manageable for producers as it is easily removed with spring tillage. In northern areas of the state a freeze/thaw cycle may eliminate this shallow compaction. This study dealt only with the effects of livestock grazing on soil compaction as measured by soil bulk density. It made no attempt to quantify subsequent impact on grain or forage yield.

References

Solie, J.B., E.G. Krenzer, & J.D. Venter. 1993. Influence of soil compaction by grazing on wheat yields. Paper No. 931565. American Society of Agricultural Engineers, St. Joseph, MI.

Walker, J.W. & R.K. Heitschmidt. 1986. Effect of various grazing systems on type and density of cattle trails. Journal of Range Management 39(5)428-430.

Warren, S.D., T.L. Thurow, W.H. Blackburn, & N.E. Garza. 1986. The influence of livestock trampling under intensive rotation grazing on soil hydrologic characteristics. Journal of Range Management. 39(6)491-495.

Table 1. Field descriptions, stocking rates, and grazing duration.

County	Field Size acres	Starting Date	Ending Date	Animal Units
Rice	108[a]	11/17/98	3/30/99	83[b]
Smith	45	11/11/98	12/26/98	37[c]

[a] The field consisted of 33 acres of grain sorghum stubble and 75 acres of wheat pasture.
[b] 83 stocker calves weighing approximately 600 lbs each
[c] 33 weaned cows, 2 bulls, and 2 yearling calves

Table 2. Bulk density and water content data separated by site and depth.

		Bulk Density, gms/cm^3		Water Content, gms/gm	
County	Depth	Grazed	Ungrazed	Grazed	Ungrazed
Rice	0-3 inches	1.43[a]	1.35[b]	0.189[a]	0.212[b]
	3-6 inches	1.52	1.51	0.220[a]	0.228[b]
Smith	0-3 inches	1.51[a]	1.41[b]	0.217[a]	0.249[b]
	3-6 inches	1.61	1.60	0.238[a]	0.244[a]

Bulk density and water content values within each row that are followed by different letters are significantly different ($p<0.01$).

Soil Quality

Bud Davis
Conservation Agronomist
NRCS
Salina, Kansas

Components of Soil Health/Quality

- Productivity: the ability of the soil to enhance plant and biological productivity
- Environmental Quality: the ability of soil to attenuate environmental contaminants, pathogens, and offsite damage
- Health: the interrelationship between soil quality and plant, animal and human health

Soil

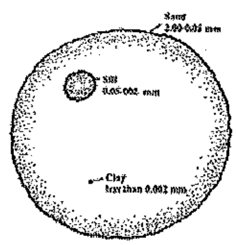
- Is the layer of minerals and organic matter on the land surface. It's main components are mineral matter, organic matter, water and air.

Soil Formation

Weathering is the decomposition of rock

1. Mechanical Weathering Processes
   1. Disintegration
   2. Freeze-Thaw
   3. Pressure Release
   4. Salt Crystal Growth
2. Chemical Weathering Process
   1. Carbonation-Solution
   2. Hydration
   3. Hydrolysis
   4. Oxidation

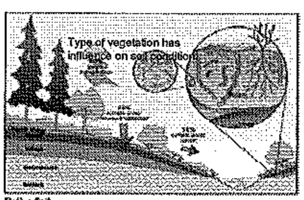
Relative Size Comparison of Soil Particles



Soil Evolution Cycle Development

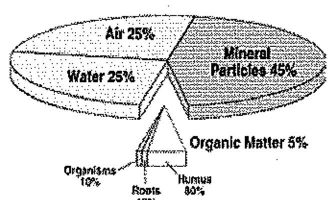
1. Weathering of Bare Parent Material
   1. Wind, Water, Heat and Cold
2. Colonized by pioneer species (lichens and mosses)
3. Then herbaceous vegetation, shrubs and finally forests.

Natural System



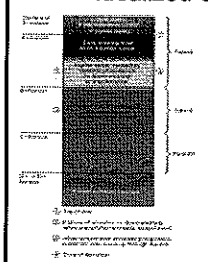
Each stage is characterized by a soil/vegetation association and environmental condition which defines an ecosystem.

Soil Composition



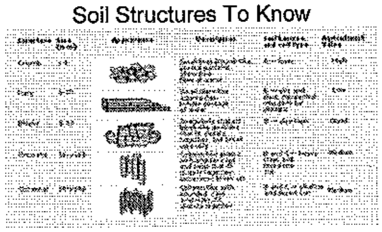
Opportunity
A favorable occasion for grasping a disappointment.

Idealized Soil Profile



Zeal
A certain nervous disorder afflicting the young and inexperienced.

Soil Structures To Know



I like long walks, especially when they are taken by people who annoy me.

Soil Health/Quality Indicators

- Physical properties
- Chemical properties
- Biological properties

Eagles may soar, but weasels aren't sucked into jet engines.

Physical Indicators

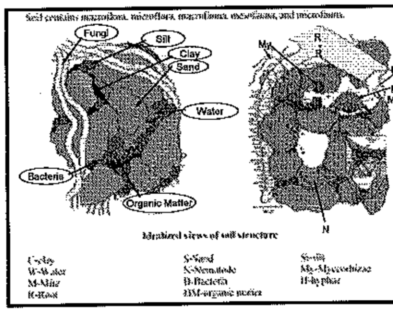
- Water-holding capacity
- Infiltration rate/permeability
- Soil texture & structure
- Soil depth
- Bulk density/compaction
- Aggregate stability
- Crusting/dispersible clay

Chemical Indicators

- Nutrient availability
- pH
- CEC cation exchange capacity
- Aeration
- Salinity
- Toxins (heavy metals, pesticides, organic compounds
- Organic matter

Biological Indicators

- Organic matter
- Microbial biomass
- Soil respiration
- Species diversity/abundance of key species
- Enzyme assays
- Mineralizable N
- Particulate (macro-) organic matter
- Metabolic quotient



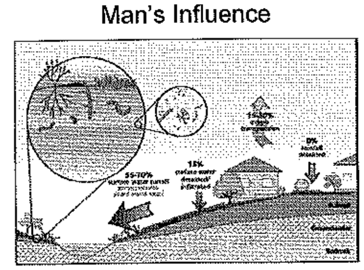
Soil Organic Matter

- Living organisms
  - Bacteria, fungi, earthworms, nematodes, insects, plant roots
- 'Active' organic matter
  - Fresh or partially decomposed
  - Labile
- Humus
  - Well decomposed
  - Relatively stable

Soil Organic Matter

- Structure, aggregation
- Infiltration, permeability
- Water-holding capacity
- Nutrient cycling
- CEC (cation exchange capacity)
- Pest suppression (biological diversity and competition)

Man's Influence



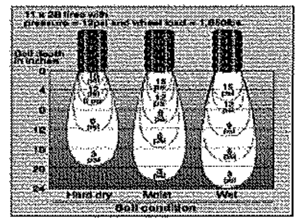
Evolutionary Change Degradation

- Destruction of the vegetation implies the destruction or modification of the evolved soils.
  - Overgrazing
  - Tillage
  - Erosion
    - Wind, water, chemical and physical

Typical of tilled cropland

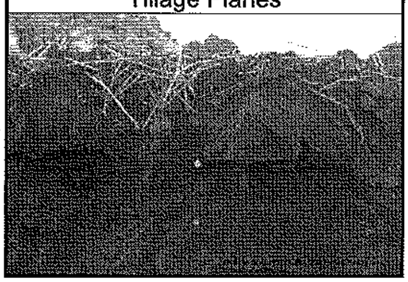
- Organic Matter = 1.5% or less
- Compacted layer-plow pan
- Low permeability—no pores
- High runoff
- Low available water
- Massive structure
- Erosion problems
- Low microorganism & invetebrate population

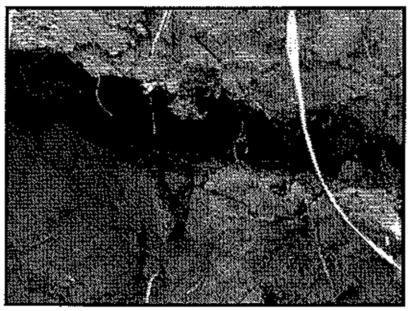
Load Effects on Soil Compaction



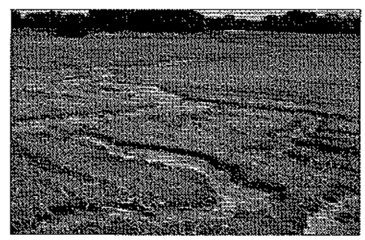
If you are going to try cross-country skiing, start with a small country.

Tillage Planes



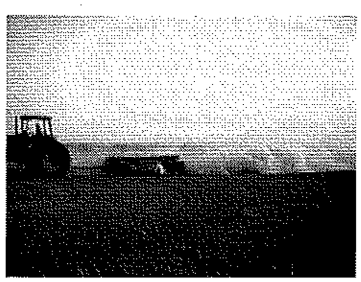


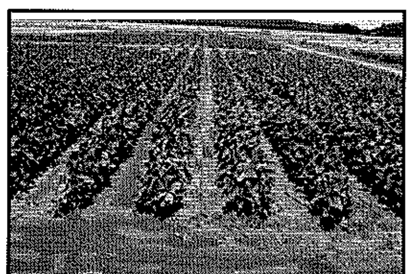
Erosion to tillage pan



Soil Degradation

- Erosion
- Organic matter loss
- Acidification
- Reduced biological activity
- Nutrient depletion
- Compaction
- Salinization
- Water logging
- Chemical toxicity





Half the people you know are below average.

Experience is something you don't get until just after you need it.

Human activity influences equilibrium

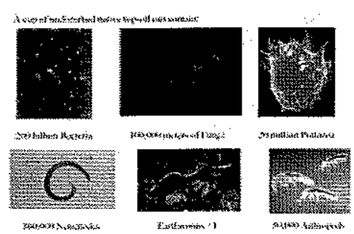
Reclamation Process

Admiration
Our polite recognition of another's resemblance to ourselves.

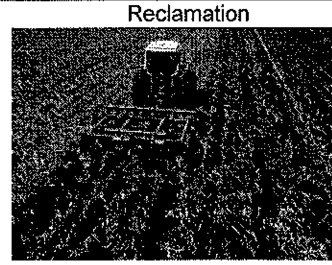
Typical changes w/No-till

- **Increased Permeability / Connectivity**
- **Better Soil Structure**
- **Decreased Compaction / Plow Pans**
- **Lower Summer Soil Temperature**
- **More Animals -Especially Earthworms**
- **Higher Root Density**
- **Fungal Mycelia**
- **Residue**
  - **Residue cycling**
  - **Evidence of Decomposition**
- **Soil Respiration**

Soil Is A Dynamic Living Habitat

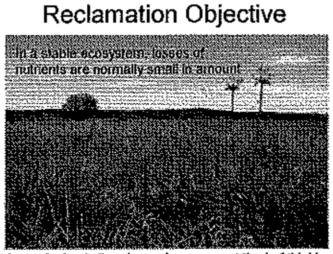


Reclamation



If at first you don't succeed, destroy all evidence that you tried.

Reclamation Objective



A conclusion is the place where you got tired of thinking.

Reclamation Components

- Reduce tillage impacts
- Increase crop diversity
- Balance nutrient input to needs
- Reduce or eliminate fallow periods
- Time

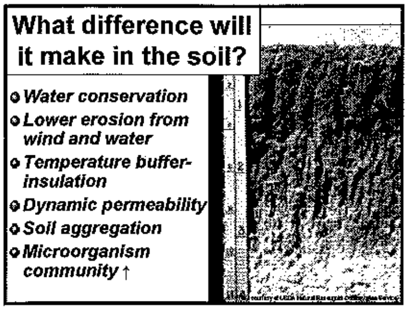
If at first you don't succeed, destroy all evidence that you tried.

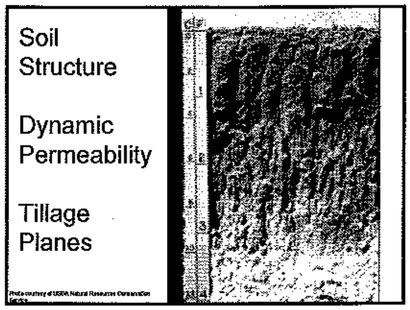
Evolution scale of No-till

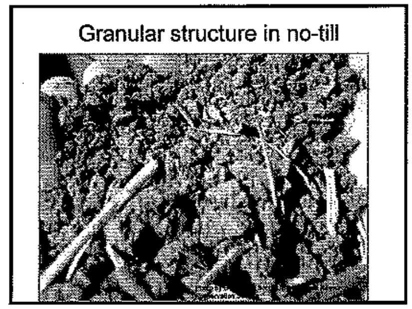
Initial Phase	Transition Phase	Consolidation Phase	Maintenance Phase
• Robust Aggregates • Low OM • Low CR • Restart MB • > N	• Increase CR • Increase OM • Increase P • Imob. N ≥ Min.	High CR • High C • > CEC • > H_2O • Imob. N < Min. • Nut. Cycling	• Continuous N and C Flux • > H_2O • > High Nut. Cycling • < N and P use
0-5	5-10	10-20	> 20

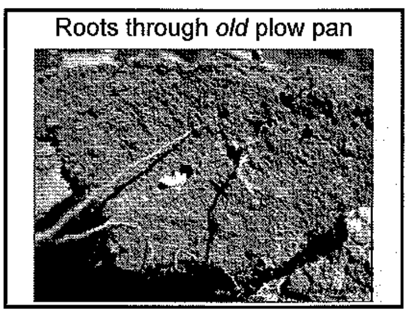
Time (years)

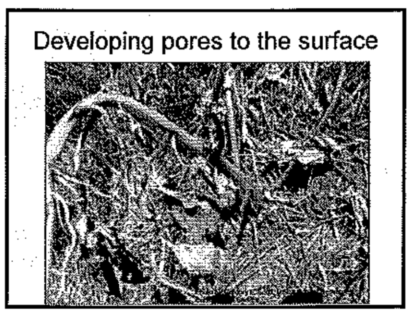
Sá, 2001

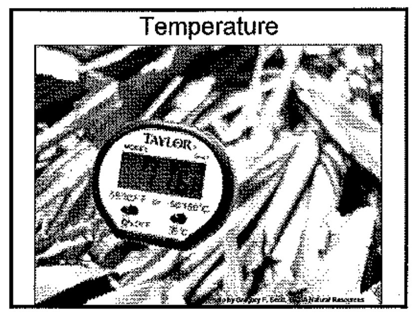

What difference will it make in the soil?
Water conservation
Lower erosion from wind and water
Temperature buffer-insulation
Dynamic permeability
Soil aggregation
Microorganism community ↑

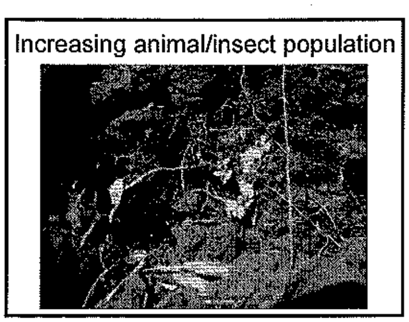

Soil Structure
Dynamic Permeability
Tillage Planes

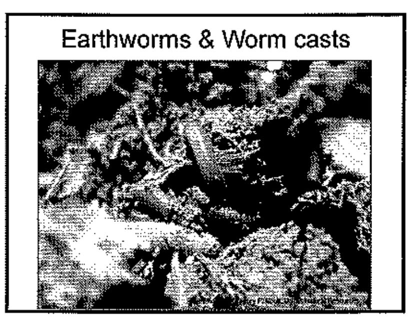

Granular structure in no-till

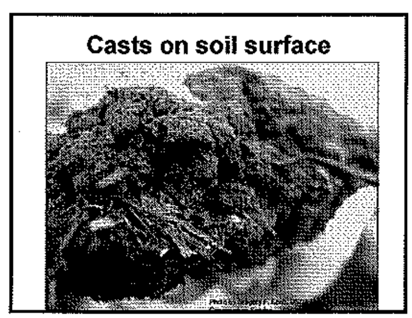

Roots through old plow pan

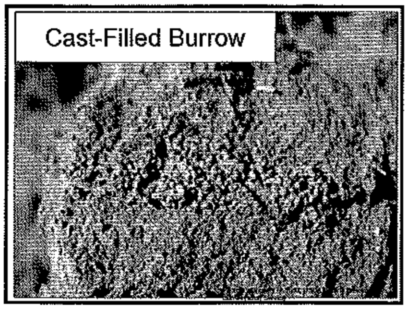

Developing pores to the surface

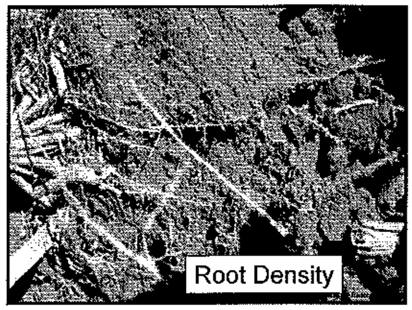

Temperature
TAYLOR

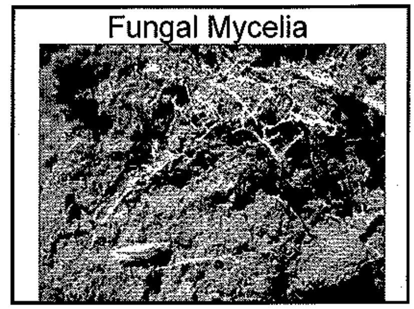

Increasing animal/insect population

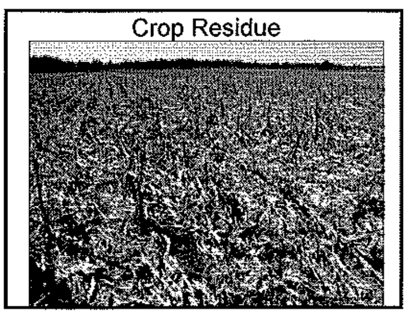

Earthworms & Worm casts

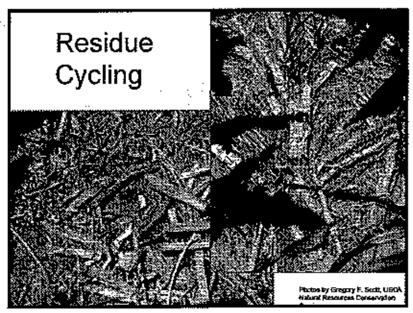

Casts on soil surface

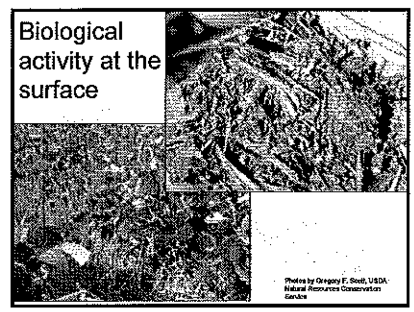












It takes time!!

1. Recovery is a soil process.

2. <u>Years--(5+)</u>

3. Nitrogen

4. Start right, stick with it

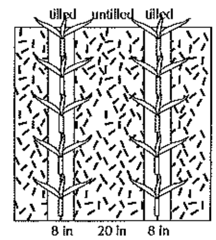
Dryland Strip-till

Brian Olson, Barney Gordon,
Jeanne Falk, Rob Aiken

Strip-till

- 'Hybrid' tillage system
- Marries benefits of no-till and conventional tillage
  - No-till
    - Conservation of moisture
    - Control of wind erosion
  - Conventional tillage
    - Warm soils for rapid emergence

Strip-till



Strip-till

Potential Benefits
- Break up surface compaction
- Deep fertilizer placement
  - Anhydrous ammonia
  - UAN
- Maintain surface residue in sprinkler irrigation systems
- Use of older (low residue handling) equipment
- Transition from conventional to reduced or no-till

Potential Risks
- Erosion on strips
- Crusting; poor stands
- Soil compaction, structural damage from tillage when soils are wet
- Seedling damage from spring anhydrous applications
- Faster loss of fragile residue

Strip-till

- Compaction zones
  - Found throughout western Kansas
  - 4-6 inches below soil surface
- Roots can't always get through compaction layer
  - roots turn at a 90° angle
- Strip-till can break up these compaction zones
  - Providing a shaft for the roots to follow

Strip-till Machine

- Basic configuration
  - Coulter
  - Discs
  - Subsurface knife for injecting fertilizer
- 15 to 25 horsepower for each row unit
- Options - disks, trash whippers, or rolling baskets

Strip-till Manufacturers

- Many companies currently selling
  - Various styles
    rent and try on your farm before buying
  - Different setup
    some are more invasive than others
    leads to more horsepower required
- List of known companies in NW KS
  - Yetter, Twin Diamond, DMI, Orthman, Quinstar, Remlinger, Redball, Blue jet

Quinter Results

Farmer assisted field study

Questions

1. Does strip-till increase production?
2. Does strip-till improve seedling survival and root growth?

Materials and Methods

- Large plots – 8 rows by 600 ft
- Conducted in 2004 and 2005
- History
  - Previous crop wheat
  - No-till at least four prior years

Materials and Methods

Strip-till treatments

all treatments had a total of 75 lbs/A of N applied

- Fall applied strip-till
  - 50 lbs/A of N applied as UAN
  - 25 lbs/A of N applied as urea 2x2 at planting
- Winter applied strip-till
  - 50 lbs/A of N applied as anhydrous ammonia
  - 25 lbs/A of N applied as urea 2x2 at planting
- Spring applied strip-till
  - 50 lbs/A of N applied as UAN
  - 25 lbs/A of N applied as urea 2x2 at planting
- No-till
  - 75 lbs/A of N applied as urea 2x2 at planting

Sunflower

(2004 and 2005)

Treatments	Test Wt	Population (plts / A) 2004	Population (plts / A) 2005	Yield (Lbs/A) Adj 10.0%
Winter strip-till	29.6	12900	18000	2225
Spring strip-till	28.9	15700	17500	2218
No-till	29.8	11200	16500	2008
Fall strip-till	29.4	13600	16800	1984
LSD (0.05)	NS	1084		167

DeKalb DKF3880 CL planted May 28, 2004 at 17,300 seeds/A
DeKalb DKF3880 CL planted May 20, 2005 at 18,900 seeds/A

Grain Sorghum

(2004 and 2005)

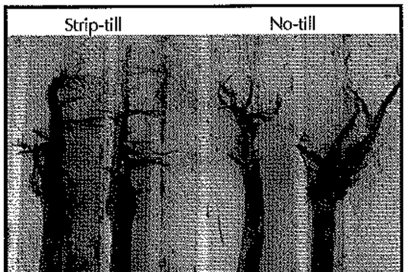
Treatments	Test Weight	Yield (bu/A) Adj. 14.0%
Fall strip-till	56.7	114
No-till	56.4	113
Winter strip-till	56.2	113
Spring strip-till	55.7	111
LSD (0.05)	NS	NS

NC+ 5B89 planted May 28, 2004 at 51,000 seeds/A
NC+ 5B89 planted May 20, 2005 at 55,000 seeds/A

Corn

Treatments	Test Wt.	Moisture (%)	Population (plts/A)	Yield (bu/A) adj 15.5%
Winter strip-till	59.9	14.6	16843	114.3
Spring strip-till	59.2	14.3	16988	100.9
Fall Strip-till	59.4	14.3	16408	100.0
No-till	59.8	14.3	15682	93.2
LSD (0.05)	NS	NS	NS	8.6

Pioneer 33B49 planted April 28, 2004 at 16,600 seeds/A



Sunflower Roots

(2004 and 2005)

Tillage	Taproot Mass	Straight Taproot	Lateral roots	Secondary roots	Average Root Score
Spring Strip-till	2.9	1.9	2.1	2.4	2.3
No-till	2.9	3.1	3.0	3.3	3.1
LSD (0.05)	NS	0.77	0.48	0.55	0.40

Grain Sorghum and Corn Roots

- Grain Sorghum 2004
  - Straighter roots with more mass in strip-till
  - No difference in laterals and secondary roots
- Grain Sorghum 2005
  - No difference between tillage systems for straightness, mass, laterals, or secondary
- Corn 2004
  - No difference between tillage systems for straightness, mass, laterals, or secondary

Summary

- For sunflower in 2004 and 2005 and corn in 2004, strip-till had higher or equal yields to no-till
  - Site had slightly higher than normal rainfall in 2004 to average rainfall in 2005 for the period of March to August (2004 – 18.46, 2005 – 17.41, Average - 17.36 inches).
- There was no benefit to strip-till for grain sorghum
- When strip-tillage is applied, sunflower roots (tap root system) will develop similarly regardless of environment. Corn and grain sorghum root development (fibrous systems) is influenced more by the environment.

Sunflower Results Across NW Kansas

Treatments

- Strip-tilling was performed in late spring – late April early May
- Treatments
  - Farmer practice
    - Reduced tillage or no-till
    - Fertilizer was applied with planter in 2x2 configuration
  - Strip-till
    - Remaining fertilizer was applied with planter in 2x2 configuration
    - At least half of fertilizer was applied with strip-till machine

Results

Environment	Compaction Zone	Treatments	Yield (lbs/A)	ANOVA	LSD
Dryland confections	Minor	Strip-till	1121	0.6807	NS
		Reduced-till	1074		
Dryland oils	Minor	Strip-till	1459	0.2651	NS
		No-till	1389		
Dryland Oils	Minor	Strip-till	1864	0.1060	NS
		No-till	1680		

Strip-Tillage for Crop Production in North Central Kansas

Barney Gordon

Treatments

Fertility Treatments

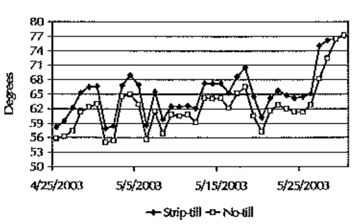
1) 0-0-0 Check
2) 40-30-5-5
3) 80-30-5-5
4) 120-30-5-5
5) 80-15-2.5-2.5(Fall) +40-15-2.5-2.5(Spring)

Timing

1) Fall Strip-Till + Fall Applied Fertilizer.
2) Fall Strip-Till + Planting Time Fertilizer.
3) No-Till Planting + Planting Time Fertilizer.

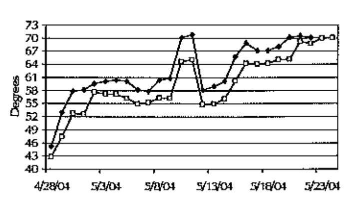
Soil Temperature at Planting Depth

Belleville, 2003



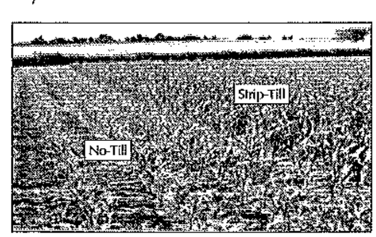
Soil Temperature at Planting Depth

Belleville 2004



No-Till vs Strip-Till

Early Season Growth



Strip-till vs No-till

Grain Yield
Belleville 2003

Fertilizer Treatment	Strip-Till Spring Fertilize	No-Till
	bu/acre	
40-30-5-5	52	45
80-30-5-5	60	48
120-30-5-5	71	51
Average	61	48

Grain Yield
Belleville 2003

Fertilizer Treatment	Strip-Till Fall Fertilize	Strip-Till Spring Fertilize
	bu/acre	
40-30-5-5	56	52
80-30-5-5	58	60
120-30-5-5	68	71
Average	61	61

Grain Yield
Belleville 2003

Fertilizer Treatment	Yield bu/acre
120-30-5-5 Fall	68
120-30-5-5 Spring	71
120-30-5-5 Split (2/3 fall, 1/3 spring)	75

Composite Information
Belleville 2003

Treatment	V-6 Dry Wt lb/a	Day to Mid-Silk	Moist %	Yield* bu/a
Strip-Till	299	56	14.5	60
No-Till	168	66	17.5	45

*Includes unfertilized check

Grain Yield
Belleville 2004

Fertilizer Treatment	Strip-Till Spring Fertilize	No-Till
	bu/acre	
40-30-5-5	161	146
80-30-5-5	174	159
120-30-5-5	186	165
Average	174	157

Grain Yield
Belleville 2004

Fertilizer Treatment	Strip-Till Fall Fertilize	Strip-Till Spring Fertilize
	bu/acre	
40-30-5-5	161	161
80-30-5-5	174	174
120-30-5-5	185	186
Average	173	174

Grain Yield
Belleville 2004

Fertilizer Treatment Strip-Till	Yield bu/acre
120-30-5-5 Fall	185
120-30-5-5 Spring	186
120-30-5-5 Split (2/3 fall, 1/3 spring)	186

Composite Information
Belleville 2004

Treat.	V-6 Dry wt lb/a	Day to Mid-Silk	Moist %	Yield* bu/a
Strip-Till	421	55	13.8	160
No-Till	259	66	16.2	144

*Includes unfertilized check

Grain Yield
Belleville 2005

Fertilizer Treatment	Strip-Till Spring Fertilize	No-Till
	bu/acre	
40-30-5-5	120	108
80-30-5-5	126	114
120-30-5-5	128	115
Average	125	112

Grain Yield
Belleville 2005

Fertilizer Treatment	Strip-Till Fall Fertilize	Strip-Till Spring Fertilize
	bu/acre	
40-30-5-5	120	120
80-30-5-5	126	126
120-30-5-5	127	128
Average	124	125

Grain Yield
Belleville 2005

Fertilizer Treatment Strip-Till	Yield bu/acre
120-30-5-5 Fall	127
120-30-5-5 Spring	128
120-30-5-5 Split (2/3 fall, 1/3 spring)	125

Composite Information
Belleville 2005

Treatment	V-6 Dry wt lb/a	Day to Mid-Silk	Moist %	Yield* bu/a
Strip-Till	320	55	15.3	123
No-Till	188	64	17.6	111

*Includes unfertilized check

Composite Information
Belleville 2003-2005

Treat.	V-6 Dry wt lb/a	Day to Mid-Silk	Moist %	Yield* bu/a
Strip-Till	347	53	14.5	114
No-Till	205	65	17.1	100

*Includes unfertilized check

Grain Sorghum Yield
Belleville 2004-2005

Tillage	Fertilizer	Timing	2004	2005	Avg
Strip	120-30-5	Fall	131	148	140
Strip	120-0-0	Fall	121	139	130
No-Till	120-30-5	Planting	117	132	125
No-Till	120-0-0	Planting	103	125	114

Summary

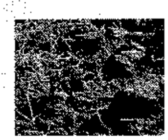
- Early-season plant growth and nutrient uptake was greater with strip-till than no-till.
- Grain yields were significantly improved with strip-tillage.
- Under Kansas conditions, fall applied fertilizer was as effective as spring applied.

Summary

- Quinter
  - Strip-till yielded as much as or more than no-tilled sunflowers (2004 and 2005) and corn (2004)
  - No yield benefit to strip-till grain sorghum (2004 and 2005)
- MAJOR QUESTION for dryland acreage
  - In a dry year, will strip-till be more harmful than beneficial due to loss of water through evaporation?

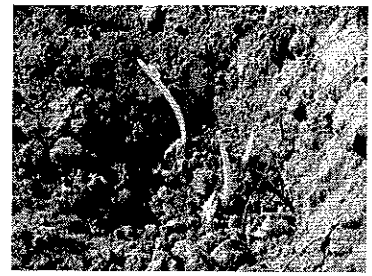
Potential Problems

- Too Dry
  - Large clods
  - Poor seedbed
  - Ground is rough to cover for herbicide application
- Too Wet
  - Little fracturing of the soil
  - Increase in soil compaction
  - Ground may not fill in shaft from fertilizer knife
  - Hard rain may cause depression to occur in strip-tilled area

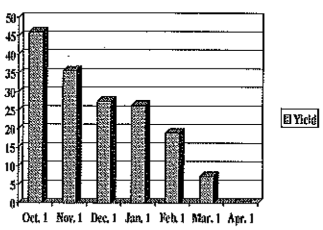


Cover Your Acres
2006

Effect of Late Planting on Wheat
Jim Shroyer



Wheat Responses to Delayed Planting Dates



Witt, Garden City

Late Planting-Colby

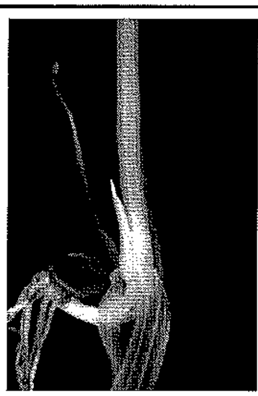
bu/a

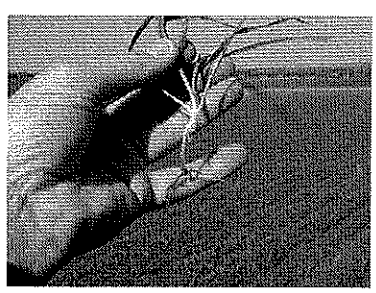
12-1-00	12-12-01	12-11-02	12-8-03	12-9-04
37	19	28	32	23

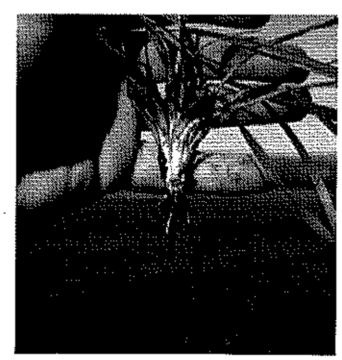
Dr. Rob Aiken

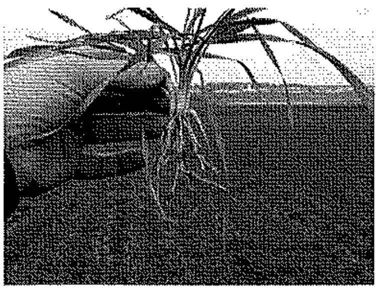
Late Planting

- Poor germination & emergence
- Poor tillering
- Poor crown root development
- Potentially more winter damage
- Grain-filling later in season
- Shorter grain-filling period







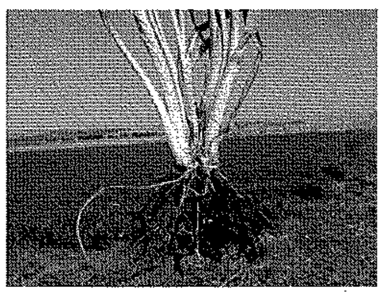


Effect of Planting Date on Fall and Spring Tiller Numbers

Plant date	Fall		Spring		Spikes
	Max	Prod	Max	Prod	$\#/yd^{-2}$
Sept 28	1266	281	584	195	476
Oct 11	916	360	659	192	552
Oct 28	183	152	600	272	424
Nov 13	147	117	213	144	260

Compensating for late plantings

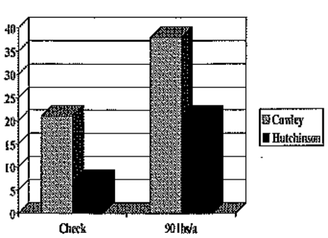
- Increase seeding rates
- Don't plant too deeply



Thickening up thin stands

- Can it be done?
- When is the best time?
- What varieties should be used?

Wheat Interseeding into Thin Stands



Yield (bu/a)

County	Fall	Spring	Difference
Clay	55	37	18
Norton	36	15	21
Osborne	40	16	24
Ottawa	60	34	26
Phillips	71	25	46
Republic	41	22	19
Riley	54	45	9
Saline	67	32	35
Avg	53	28	25

Farmer Panel – Fallow versus Continuous Wheat

Dennis Leichliter, Shannon Metcalf, Spencer Braun, Brooks Brenn,
Northwest Kansas Crop Residue Alliance Members

Farmer Panel – Crop Rotations

Greg Grafael, Dan Skrdlant, Stan Miller, Brooks Brenn,
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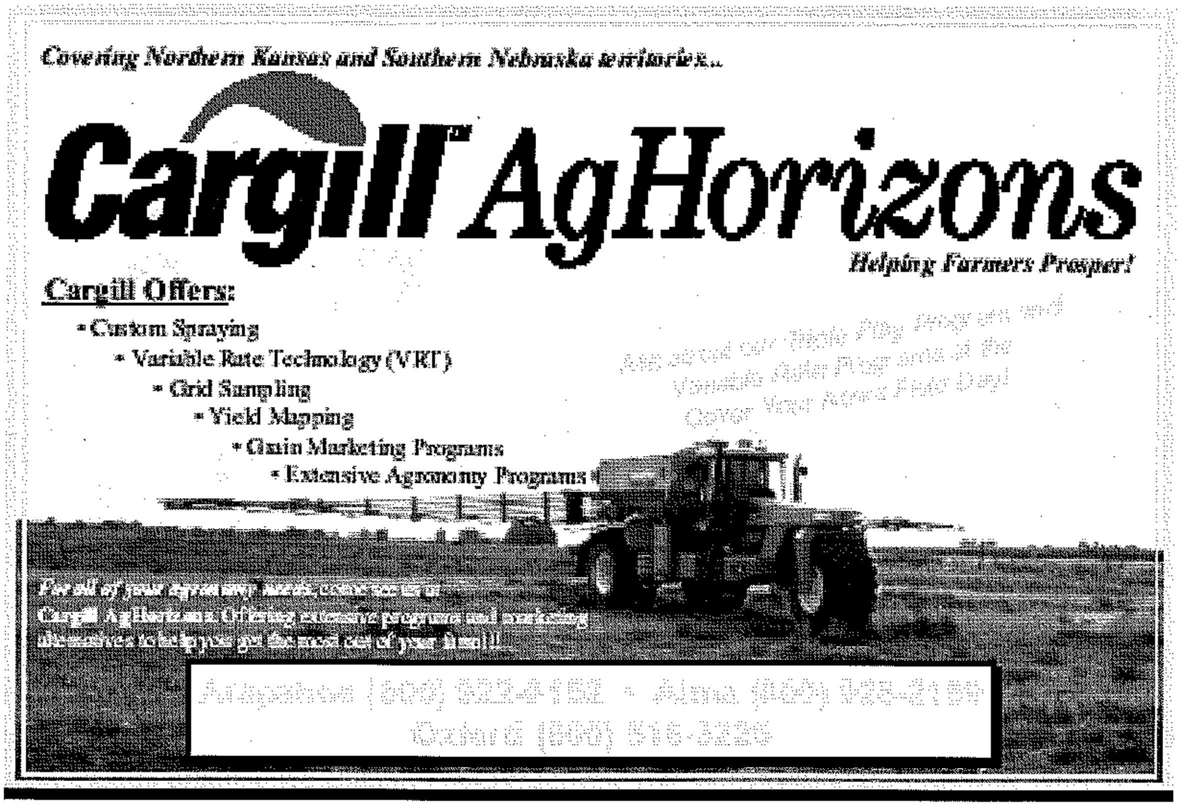

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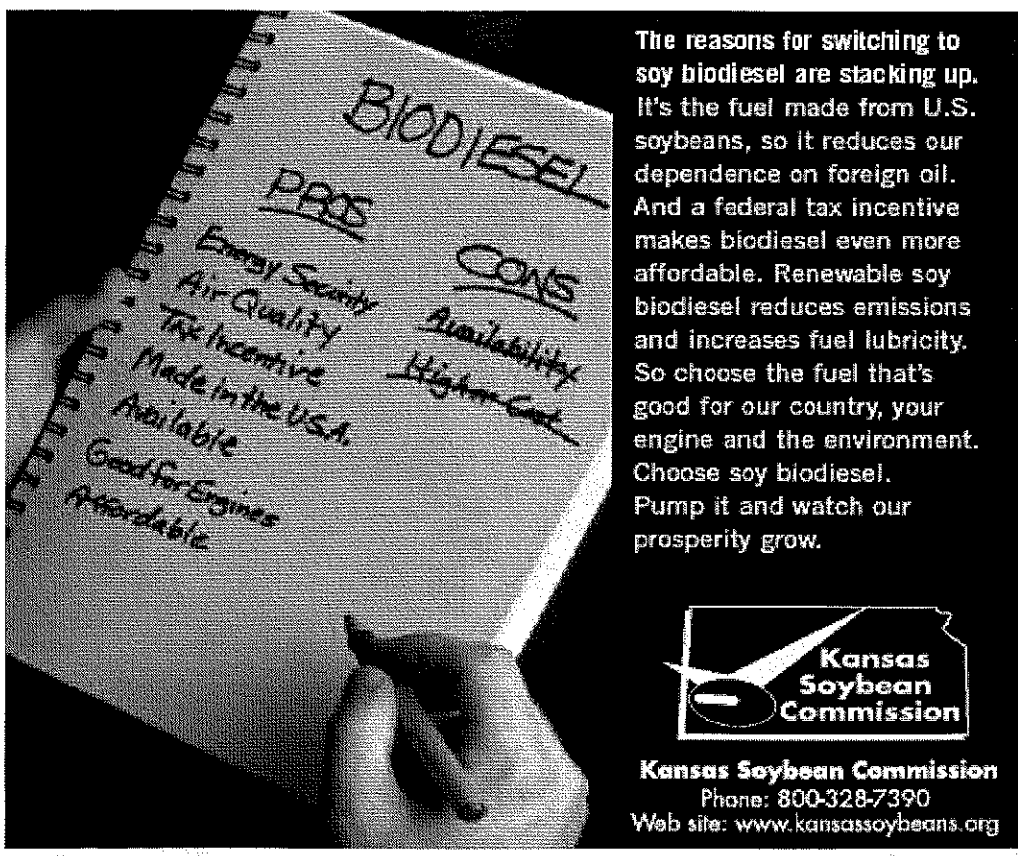

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