Leading Edge
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No·till On The Plains

An Abundance of Opportunity

by Matt Hagny

Red Rock, Oklahoma no-till producer Tony Kodesh is always thinking, always searching for new efficiencies to be gained. He usually has several back-up plans in store as well. That flexibility has come from years of wrangling with the extreme variability in weather so common in his part of world. Not much fazes Kodesh anymore: "With all the different crops we grow, what we lose on one crop we will make up for on another. Weather that is bad for one crop is often just right for a different crop." Plus, he has the added opportunity to hay or graze crops in the rotation.

Photo by Matt Hagny.

Heavy residue is no trouble for Tony's JD 1850 air seeder.

Kodesh's flexibility certainly isn't a random scattergun approach to management—lots of planning and research goes into the process. Tony started farming in 1978 in the manner typical for the area at that time, with lots of plowing and wheat grazing. The tillage part always bothered him. He understood the concept of needing a firm seedbed to enable the seed to draw moisture from the surrounding soil. What he couldn't make sense of was "tearing up the perfect seedbed of a stubble field, and then needing to pack it back down again for planting."

That question led him to explore no-till further. In the fall of '95 he bought a 15-foot JD 750 drill, never having seen one before, and set out experimenting with no-till seeding. He struggled a bit at first, especially

Photo by Matt Hagny.

Rotations and intense management pay off in high-yielding wheat for Oklahoma no-till producer Tony Kodesh. Note the thick uniform stand.

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with hairpinning of the wheat straw in muddy fields, which left most of the soybean seed on top, prompting him to ask himself, "What have I done? —This drill won't plant anything!" He kept after it. As the soils firmed up, the hairpinning problem went away. His no-till crops were rather successful during those early years, and he always had plenty of custom work to keep the drill busy.

"The benefits of no-till far outweigh any negatives. We manage our risks so much better with no-till."

In January of '97, Tony attended the first 'No-Till on the Plains' conference in Salina, KS, where hearing Dwayne Beck convinced him that he was on the right track. As they returned home from the conference, he told the other farmers riding in the same car that he was going to go "whole hog" and sell his tillage equipment, which he did that spring. He has been 100% no-till ever since. Today, Tony says, "I really like where we're at. The benefits of no-till far outweigh any negatives … I didn't like the direction we were going for profitability prior to no-till. We manage our risks so much better with no-till."

Photo by Matt Hagny.

Tony shows us the wheat and milo residue in his cotton field. He's optimistic about cotton in his rotation, noting the crop's resilience and profit potential. Cotton handles the hot dry weather rather well, and is gaining acres in Oklahoma and south-central Kansas.

Turbocharged Rotations

The cornerstone of that risk management is of course diversity. Diversity not only of crops, but also in how they fit into rotational niches and how they are managed. For instance, young pure stands of alfalfa are managed for hay in the usual fashion, having been no-till seeded in either the fall or spring. Tony consistently achieves excellent stands with 10 lbs/a of alfalfa seed with his 1850 air drill, seeding directly into the stubble without baling or burning any of it. Kneeling in a perfect stand of alfalfa seedlings amidst heavy wheat straw, Tony grabs a handful of the straw and exclaims, "Why would anyone want to get rid of this?"

As the alfalfa stands get thinner over the years, Tony proceeds to seed wheat directly into the live alfalfa. The wheat is then fertilized and managed for grazing ("no incidence of bloat so far") or hayed off as a wheat/alfalfa blend (Tony feeds most of his own hay). Occasionally they have kept some for grain as well, which generally yields from 40 to 65 bu/a in this scenario. Tony explains that it is really the perfect combination, "Alfalfa is only active when it warms up in the spring, and before it gets too dry in late summer. Wheat fills in the time when alfalfa isn't doing anything." He also notes that grazing interseeded wheat reduces alfalfa weevil numbers. When the alfalfa finally gets too thin to make respectable hay crops, it is killed with herbicide and he goes on with his cash crop rotation, typically starting by seeding wheat for grain into the killed alfalfa.

Leading Edge

No·till On The Plains

Editors:
Bud Davis
Matt Hagny
Roger Long
Randy Schwartz
Keith Thompson

E-mail: editor.leading.edge@notill.org

Subscriptions & Advertising:
Tim Christian
Drue Durst

Phone: 888.330.5142
E-mail: tchristian@kscable.com
ddurst@kscable.com

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No-Till on the Plains Inc.
P.O. Box 236
McPherson, KS 67460-0236
888.330.5142
Website: www.notill.org

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No-Till on the Plains Inc's Mission: To assist agricultural producers in implementing economically, agronomically, and environmentally sound crop production systems.

Objective: To increase the adoption of cropping systems that will enhance economic potential, soil and water quality, and quality of life while reducing crop production risks.

In a twist on this scheme, Tony takes established stands of bermudagrass and drills wheat into it in the fall. The wheat provides an extra grain or hay crop before the bermuda gets active again in late spring. A light fall frost sends the bermuda back into dormancy and allows for wheat establishment. Tony really likes the "tremendous" hay the bermudagrass produces, and notes that it is easy to manage.

Besides wheat, alfalfa, and bermuda, Kodeshes' crops include soybeans and milo, and occasionally some cotton or cowpeas. The soybean and milo acreages are spread further into both single-crop (full-season) and double-crop after wheat, giving them an opportunity to take advantage of rains whenever they may come—a necessary strategy in central Oklahoma. Their rotation is typically a two-year cycle of cash-crop wheat, then a double-crop of soybeans or milo, followed by a full-season soybean or milo, or occasionally cotton—thus harvesting 3 crops in 24 months. The cycle starts again with wheat seeded into the soybean, milo, or cotton stubble. *(Editors: while successful so far, and certainly an improvement over continuous wheat, Kodeshes' alternate-year wheat may run into significant problems in the future. To maintain a high percentage of wheat, doing two wheat crops back-to-back and then staying out of wheat for 2 or 3 years would be better—recall the 'Stacking' article in the Dec. issue.)*

Photo by Matt Hagny.

Tony examines seedling alfalfa for nodulation. Kodesh no-till seeds the alfalfa directly into his abundant wheat stubble. Good alfalfa stands—no problem!

Photo by Matt Hagny.

Kodeshes' double-crop milo made something of itself even in the tough '01 season, due largely to the heavy wheat stubble remaining on the surface. In managing around Oklahoma's erratic weather, Kodeshes sometimes utilize cattle to do their harvesting for them.

Kodeshes' rotations are continually being analyzed and modified. They have had a thousand acres of soybeans every year since '98 and have never had farm avg. yields below 20 bu/a until this past year. Tony still isn't shook up: "We have insurance for the bad years. And while 20 bu/a beans may not sound like much, we make up for it in the following wheat crop. Wheat following soybeans is very inexpensive to grow—you just plant and fertilize it—and it produces tremendous yields most years." Tony is enthusiastic about cotton, which he tried in '98 and again in '01. Last year, heavy rains and cold temperatures after planting severely thinned his cotton stand, causing him to plan on killing it out and replanting the field to milo. His son convinced him to keep the cotton, which went on to produce 375 lbs/a of lint, with basically no inputs or management other than spraying out the weeds (it was Roundup Ready) and applying a defoliant and boll opener to hasten harvest. "This year really proved to me just how tough the cotton plant is. It really requires far less management than I originally thought."

Tony isn't quite so thrilled with his milo, although he recognizes its importance in diversifying the rotation. He notes that trucking consumes a disproportionate amount of low-value grains such as milo, with obvious effects on profits. Kodesh also recognizes milo's importance in lengthening the rotation, and that the atrazine used in the milo year is particularly good at controlling ryegrass, which is somewhat problematic for some other herbicides in other crops. Kodesh says he has really cut his weed pressure, particularly crabgrass and bindweed, with improved rotations and low-disturbance no-till.

Wheat: 'To the Hilt' Management

The most intensively managed crop in Kodeshes' rotation is the wheat, a crop that many producers and even some researchers condemn as being unresponsive to management. That certainly hasn't been Tony's experience. Tony uses the agronomic guidance of OptiCrop consultants to produce exceptionally high-yielding high-quality wheat, much of which is conditioned and sold as certified seed. Tony almost always has wheat yields running around 60 bu/a and up, and has had several years with

High-management wheat: yields really took off once Kodesh got away from monoculture wheat.

fields of 90+ bu/a. Tony attributes the consistently good results to a number of things, but says the yields really took off once they got away from monoculture wheat. "It's really the whole program: proper stand establishment, fertility, rotations, and so on—you can't leave anything out or you won't get good results."

Good wheat management for Kodesh starts with high-quality seed no-till drilled into soybean, milo, or cotton stubble, or into killed alfalfa (the wheat planted into *live* alfalfa stands generally isn't intended for grain, and so is managed differently). Wheat managed for high grain yields is planted at a rate of 30 seeds per square foot; late plantings (Nov.) are increased to 35 or 40 seeds/sq. ft. Care is taken to get it at a consistent depth, usually about 1½ inches. Tony is somewhat concerned about the uneven seed distribution within the row by the 1850's air system, but has been unable to resolve the problem. During seeding, some rows are shut off every 60 feet to create tramlines for the sprayer to follow later. All wheat seed is treated with fungicide, and some with systemic insecticide as well—Tony believes controlling aphids in the fall is important, since they sometimes vector the barley yellow dwarf virus. Tony notes that later planting certainly helps avoid aphid and BYD problems, but runs the risk of the weather turning too wet to get the wheat planted.

The high-management wheat is planted considerably later than the wheat for grazing or haying, and is also fertilized differently. All the wheat gets a 12-30-20 blend of dry fertilizer applied in-furrow at planting. The intensively managed wheat receives no further N until mid-January when it gets a shot applied as a UAN stream with Kodeshes' RoGator—they always stream the UAN rather than spraying it, due to potential for increased N losses and residue tie-up with sprayed UAN. The second shot of UAN is applied at first joint, about mid-March, again as a stream. Any foliar fungicides, insecticides, or herbicides are applied in separate passes. Although Tony has applied foliar fungicides 4 out of the last 5 years, and sees the yield responses to justify doing so, he also notes that the rotations have cleaned up his weeds to the point of not needing any herbicides on his wheat the last two years.

Photo by Matt Hagny.

Tony strives to keep the soil covered with plenty of crop residue.

Having seen the successes of intensively managed wheat, Tony is beginning to turn his attention to the summer crops. "We started with the wheat, because we knew we could grow it profitably and that it responded to management." Kodesh notes that the summer crops are still rather inconsistent, which may preclude some advantages of intensive management.

Flexible and Aware

All Kodeshes' wheat acres are double-cropped to either milo or soybeans. Tony says they've always had enough moisture to plant their double-crops, which he partly attributes to timely wheat harvest and keeping the straw upright by using a Shelbourne stripper head since '98 (not to mention the truly heavy straw resulting from their intense management of the wheat crop). Tony has also tried double-cropping cowpeas for forage. He notes that when he turned the cattle out onto the green cowpeas, they ate all the crabgrass and pigweeds but wouldn't touch the lush cowpeas. Later, after the cowpeas had started maturing, the cattle devoured them.

In another instance of discovering opportunity, last year when his double-crop beans failed, Tony turned the calves onto them and reports that they gained 2 lbs. per day. Tony also mentions that if a big wind should flatten his double-crop milo before he gets it all harvested, cattle could salvage much of it. He explains that he doesn't have trouble with cattle rutting the field like he did during his tillage days—the soil has regained structure and the heavy stubble helps support the animal hooves when the soil gets wet. Commenting on the firmness of the soil under foot, Tony sounds almost indignant at having to state what should be common knowledge: "There's *no need* for ripping this—the crops grow just fine." Indeed, this is the soil's natural state.

Kodesh grid samples and uses that information to variably apply lime when needed. Tony says the surface application of fine water-plant lime works just fine. "I've seen major growth and yield differences in both

soybeans and wheat on the first year following surface application of the lime."

Kodeshes' management also emphasizes low overhead, simplicity, and timeliness. All of their seeding is done with the 7.5-in. Deere 1850 air drill that they purchased in the spring of '98, and Tony says it has planted over 10,000 acres *every year* since then (they do quite a bit of custom work). The openers are carefully maintained and frequently adjusted to maximize performance. "I don't think I'd want any other opener." Not only does it plant his wheat, soybeans, and alfalfa, but also the milo and cotton. He is contemplating adding a planter in the future, but really likes the simplicity and speed of the air drill. He recognizes the compromises, and notes that his current perspective is that "getting over the acres on time is more important than having every seed at exactly the right spacing." Still, he thinks economic advantages may exist to having his cotton put in with a 30-in. planter, and perhaps the milo as well.

Photo by Matt Hagny.

The 1850 drill leaves the stubble mostly intact.

It Just Gets Better

Despite doing all their own planting, spraying, fertilizing, and harvesting (except cotton), plus tending the cattle and handling seed, they have no full-time hired help (they did have a full-time hired man in their tillage days). Tony's wife, Connie, does much of the finances and keeps the data organized. Their son and three daughters help with field work when possible, since they all attend nearby colleges and high school. They have some additional part-time help in the summer, mostly for wheat harvest. Tony says, "We can get so much more done now that we're not doing all that tillage." They seem to be putting that time to good use, either with expanded farm activities or family time.

No-till is a clear winner for Kodesh. He is painfully aware of the erosion occurring on tilled fields in the area. He laments the destructiveness and the productivity lost just in the last 80 or 90 years that the soil in his area has been tilled. Tony is very proud of the fact that any water running off of his no-till fields is crystal clear, versus the mud coming off of neighboring tilled fields. Tony points out that while tillage is destroying so much land, his fields are actually improving in productivity: "My infiltration is getting better, rooting is better, organic matter is up."

Photo by Matt Hagny.

Tony has fields of established bermudagrass used for hay, but drills wheat into the bermuda when it goes dormant in the fall; the wheat is taken as an extra hay crop in the spring before the bermuda gets going again.

"It's all about turning moisture into grain, and we do that better with no-till."

For Kodesh, "It's all about turning moisture into grain, and we do that better with no-till." He mentions, "The last four years have been a blur," referring to his drastic and continual overhaul of his operation and the exciting results. When asked about problems with no-till, he says, "It just gets better every year." He returns to a point Dwayne Beck made at that first conference: no-till will work anywhere—it doesn't matter where you're at or what type of soil you have. He points at the undisturbed soil in the field where we stand, "I already have the perfect seedbed, any time I care to plant. Why would anyone want to destroy that?"

Seeding Success

by Keith Thompson

TECHNIQUE

Keith Thompson is a longtime no-till producer near Osage City, KS

While many important decisions are already in place by planting time, the most crucial step towards profitable crop production takes place during the seeding operation. It goes without saying that before you ever head to the field, the most important piece of equipment on the farm should've been thoroughly checked out and the maintenance done—but I'm not referring to that shiny new tractor or that cool four-wheel-drive pickup. No, the most important piece of equipment a farmer has is their planter or drill. If the planting equipment isn't doing its job then all that high-priced seed, fertilizer, herbicide, and whatever else one uses to grow a crop will be completely wasted (maybe not in the sense that the input is physically gone, just that the chance to make a profit has evaporated). I know this is true because I have personally made nearly every mistake possible during one planting season or another. Let's look at five things that affect stand, vigor, and yield: placing fertilizer, moving residue, placing the seed, seed firming, and seed covering.

If the planting equipment isn't doing its job, then all those other inputs and efforts will be completely wasted.

Research, experience, and reports from plenty of other no-tillers convinces me that putting down starter fertilizer will improve yields in corn and milo. I'm talking 2x2 (actually 3x0) placement here, not the in-furrow pop-up, for applying ⅓ to all of the N and possibly some other nutrients as well—one can and should put some phos. fertilizer with the seed, but N in the pop-up must be very minimal and isn't enough to get corn or milo off to a great start. For 2x2, a single-disc fertilizer opener works great because it improves the function of the rest of the planting equipment by cutting the residue so that the residue manager (row cleaner) can handle it more easily. Note that the fertilizer opener doesn't need to run particularly deep.

As more residue is left on the surface, a residue manager can help you by moving some (say 70%) residue out of the path of the opener and straightening up the rest to stop 'hairpinning' of the residue into the seed trench. Hairpinning happens when the opener fails to cut through the residue and instead tucks it into the furrow in a 'U' shape; hairpinning is worst when straw is thick and bunchy, and when the soil isn't firm underneath (nothing solid for the opener blade to cut against). Now if you don't have much residue on the surface, or you wait until the residue is completely dry and you aren't trying to plant into cool soils, then moving residue isn't a big concern. But I have found that, at a mini-

Photo by Matt Hagny.

What went wrong? Severe hairpinning of residue occurred on a damp foggy morning—the row cleaners should have been adjusted to move more straw out of the way. Hairpinning results in poor seed-to-soil contact and increased allelopathic effects, resulting in gaps in the stand and uneven plant size.

mum, straightening up the residue and moving at least some of it sure helps on controlling planting depth.

Precise Seed Placement

Creating conditions for all the plants to come up within 48 hours of one another keeps the competition between the plants to a minimum (the last ones up basically become weeds). So let's look at the 'optimum' depth for some different crops: corn ~ 1½ inches, milo ~ 1 to 1¼ inches, soybeans ¾ to 1½ inches, although deeper seeding may sometimes be necessary to find adequate moisture. Some crops like corn and wheat need to be at a certain minimum depth for proper crown root development, while others like soybeans need only be in adequate moisture. Realize that going deeper than necessary results in placing seeds into colder soils as well as increasing the distance that the seedling must push through before emerging, both of which drastically increase the stress on that seedling and add to variability in emergence timing within the row. Planting deeper than required also results in more soil compaction, opener wear, and horsepower required. Checking depth can be tough to do and I don't feel using a tape or ruler works all that great. Instead, I check depth with this nifty little digger from a seed company that is pointed with markings every ¼ inch. I've found that corn planted at 1½ inches sure looks too deep, until I checked it with my gauge. Also, be sure to check depth in several places—you won't get a second chance to get it right.

Photo by Matt Hagny.

This planter was working great: when the residue manager moves 50 to 70% of the straw out of the way, things go so much better. Note how heavy the straw is, and that all the corn plants are at the same growth stage (this corn had no rain on it from planting until 2 days prior to this photo). Attention to detail at planting can pay big dividends.

Single-disc or double-disc openers—which is best? Let's worry first about making sure the blades are sharp and not worn too much—the design issues can be debated some other time. Dull opener blades cause more hairpinning and are more difficult to push into the soil. Another thing I've seen on single-disc openers is that the gauge tire needs to be touching the blade, since this helps hold the sidewall together long enough for the seed to get to the bottom of the trench. We have at times experienced problems with dry soil falling in with the seed due to the gauge tires being worn out and too far from the opening disc. This can also happen if the edge of the seed boot is worn out.

Double-disc openers need even more attention, not only for needing sharp blades, but for keeping the seed tube and seed-tube guard components functioning properly. Again keep the gauge wheels tight against the openers—we want the sidewall to stay intact until the seed is placed. Keeping the sidewall intact and achieving consistent depth require enough down-pressure on the row unit to ensure the gauge tire stays on the soil surface continually.

Simply checking to see that the gauge tires are firmly on the surface when the planter is stopped isn't enough (like a car suspension, the row units 'ride up' when moving); look in several places along one furrow to determine if the opener is maintaining a consistent depth—all too often what a person needs is more down-pressure or frame weight, *not* a deeper setting on the gauge mechanism.

Germination Zone

The next thing that needs to happen is for the seed to be pressed firmly into the bottom of the seed trench. I'm not going to recommend any one piece of equipment to use, but basically there are the ones that slide along in the trench to push the seed into the bottom, or a wheel that does the same. Each has its pluses and minuses; the sliders are pretty cheap and simple but under certain conditions gather mud on the sides, and sometimes don't do enough firming (watch them like a hawk). The wheels have bearings to go bad, and many are too wide to get to the bottom of the trench to press the seed in properly, or are too small in diameter and fill up with mud rather quickly. Either firming device is better than having nothing, and designs are getting better. (I want something perfect that works all the time; maybe some day?)

I can say with certainty that we have consistently been getting better stands and higher yields than when we were using a tillage system.

Photo by Bud Davis.

Keith Thompson with another perfect stand (he works hard at it). Perfect stands are no accident. But with the right knowledge and equipment, achieving excellent stands and vigorous crops is easier with no-till than in tillage systems.

We almost are done, but one of the most important things is needed yet: break up the sidewall and cover the seed. The standard wheels work okay if you have wonderful soil and it's not too dry or too wet (I'd like to meet that guy who farms under perfect conditions—I saw the picture in a magazine once). A spoked or scalloped closing wheel helps accomplish this goal. A solid wheel will work okay when everything is optimum, but can cause the sidewall to be compressed so hard that the seedlings can't break through, or under some conditions the sidewall will dry out and open up to where I could see the seed at the bottom of the seed trench (it did show the seed firmer was working!) An improvement is a spoked wheel to break up the sidewall and place loose soil over the seed. Various shapes and designs of spoked wheels are available, and brackets to hold them at different angles. Depending on the configuration and characteristics of your soil (how long in no-till, texture, etc.), the results can range from excessive lifting of the sidewall and pulling seeds loose, to not enough sidewall breakage or too much packing. Some designs also have trouble with mud build-up.

These are some things we have done to our planter and drills, and I can say with certainty that we have been getting better stands and higher yields more consistently than we did when we were using a tillage system. I attribute this to the no-till system, changes in soil condition, and careful setting up and adjusting of the most important piece of equipment on our farm. Changes were made to meet the goals of getting the fertilizer near the seed, moving some residue, making sure the seed gets to the bottom of the seed trench, pressing it into the trench and destroying the sidewall. Getting your no-till seeder to meet these goals will go a long way toward a successful year.

Photo by Matt Hagny.

A planter setup similar to Thompson's prescription. The attachments he describes may not be important in ideal conditions, but can make the difference between getting a stand or not when under adverse conditions. Thompson, who scuba dives and does crazy things on mountain bikes, likes the adventure in his personal life, but won't tolerate unnecessary risks in crop production!

Editors' Note: Of all the permutations being studied of various fertilizer ratios in this or that placement or timing, the consistent take-home message is that high amounts of N fertilizer placed in a concentrated zone need time to 'temper' to prevent root burning and poor uptake early in the season. If high amounts of N are placed '2x2' then some of the phosphorous needs to be somewhere else (like in the seed furrow) since the crop needs this very early and can't access it in the 'hot' zone with all the ammoniacal N. Similarly, studies often show the desirability of having the separate starter opener as close as possible to the seed furrow but yet a safe distance from the seed (which depends on amount applied, soil conditions, etc.) —but neglect the possibility of putting a reasonably safe amount (mostly P) in the seed furrow and putting the rest of the fertilizer several inches away or b'cast. While pop-up and 3x0 placement can produce dramatic early growth differences, the yield advantage is often underwhelming—however, better early growth certainly improves crop competition with weeds, which has value, and sometimes the early nutrient availability does translate into significant yield advantages. The best choice will depend on pricing of fert. sources, and equipment and labor available.

Editors, Again: We beg to differ with Keith—the most important piece of equipment on your farm is the information processor—your brain! If this device isn't working properly, you'll never get the other pieces of steel, plastic, and silica to work right. Keith's brain appears to be functioning rather well, despite occasional head trauma over the years (too many mountain bike crashes).

Performance Boost for JD 750-type Drills

(also 1850 and 1560/1860 models)

Wonderful results—that's the report from a large number of no-till producers using the (Case-IH) SDX firming wheels (a 5/8 x 9-in. rubber wheel) on their Deere 750/1850 and 1560/1860 drills during the past two years. The SDX firming wheel is much narrower than the original Deere firming wheel (the Deere wheel is a full one inch wide), so the SDX wheel fits down into the 'v' of the furrow dramatically better.

The SDX wheel (part no. N306145A1) retails for about $23 from Case-IH and bolts right onto the original Deere arm (note that this is the firming wheel we're talking about, *not* the closing wheel). When looking to improve the performance of these drills, this is one of the first modifications that should be made —seed-to-soil contact is just too critical to leave to chance.

Coming in the Next Issue!

Running Faster

Feature Farmer Craig Stehly of Mitchell, SD is always advancing, whether learning from others or doing his own experiments on seeding equipment, cover crops, longer rotations, or whatever. The Stehly family started no-till back in '86 and was 100% by 1990, with current rotations including stacked wheat in an area typified by corn >>soybeans. When it comes to management, Stehly leads the pack.

Finding a Way

In the heart of continuous wheat & plow country, Feature Farmer Les Sims of Mulvane, KS converted 100% to no-till in '96 and "hasn't looked back." Axing the tillage and adding crop diversity allowed Les and son Fred to cover more acres and achieve their financial goals. A die-hard number cruncher, organic gardener, and former Boeing engineer, Les Sims definitely isn't afraid to think different!

Understand Your Weeds

While diverse rotations and low soil disturbance will reduce weed pressure substantially, we still rely on herbicides to give the crop an advantage over the remaining weeds. Repeated use of a certain method for control will result in shifts in the target population, and this certainly holds true for herbicides. So, are we creating resistant weeds, or was the tolerance always there and we simply culled out the susceptible ones? Are some species inherently more likely to develop resistance? What can be done?

Kansas No-Till Tour 2001

Many inquisitive no-tillers, researchers, and agronomists joined the inaugural run of this Tour, and had plenty to see and discuss. We'll touch on all the highlights and insights in the next issue.

How Did We Get Here?

A Brief History of Crops

by Matt Hagny

PERSPECTIVE

Matt Hagny is a consulting agronomist for no-till systems, based in Salina, KS

On the U.S. Plains, why do we grow red wheat but virtually no white wheat? Why is Kansas predominantly wheat, but almost no other cool-season crops—peas, lentils, canola—are grown? Why do we grow yellow corn instead of white corn? Why are the corn hybrids commercially available in the U.S. so poorly adapted to the southern Plains of the U.S., despite corn being a C4[1] plant and originating in the tropical mid-elevations of what is now southern Mexico and Guatemala?

Most of the answers to these questions are wrapped up in history, and are not necessarily the best indicator of what can or cannot be grown in a certain location. I'm not denying that crops originated in certain climates and tend to do the best when grown under somewhat similar conditions. But genetics are quite malleable, and intensive breeding efforts have created some highly diverse characters within any single crop species. There are wheat types that survive tough winters, what we call 'winter wheats,' that can survive as far north as North Dakota, Manitoba, and Saskatchewan in most years. Other types do not need vernalization (the plant's requirement of cold temperatures to reach reproductive phase) and will not generally survive harsh winters, and these are called 'spring wheats.' But no sharp line divides them, and many wheats that are grown in places like Australia or Argentina are mostly in that grey area, with some cold tolerance but no real vernalization requirement. The variety 'Jagger' is similar.

Then there are wheats that are very quick to do their grain fill, such as all the varieties grown on the U.S. Plains. The reason is that they have been bred to finish quickly to avoid substantial yield loss from high temperatures (the same 'Continental' climate features that produce our cold winters also contribute to hot summers, and a relatively short spring separating them)—wheat being a C3 plant with a maximal photosynthetic rate occurring at about 50°F (10°C). Wheat varieties grown in the Pacific NW, or in England, or in Australia, all have genetics that take advantage of the very mild winter and slow warm-up in those regions, which allows the plant to do grain filling over a very long time, to produce and finish a huge number of tillers per plant before it gets hot. Many of those areas produce very high yields of wheat (easily 100 to 150 bu/a) and other winter cereals[2]. Needless to say, the varieties grown in those areas would fare poorly in Kansas. In addition to growth habits, there is also a wide variety of grain characters amongst wheats, including not only the soft and hard reds with

Photo by Matt Hagny.

The U.S. Plains wasn't always monoculture wheat. What have we lost along with the crop diversity?

[1] There are two types of photosynthesis, referred to as C3 and C4, depending on the number of carbons in the sugar molecule produced. C4 plants, such as corn, milo, sugarcane, and cotton, have tropical origins and generally are adapted to higher temperatures than C3 plants.

their different uses, but also white wheats which are very important worldwide. So we have this one subspecies of crop (common wheat, or *Triticum aestivum ssp. vulgare*) with all these different characteristics.

Corn is similar. We have single-cross hybrid seed available in the U.S. & Canada in everything from a 70-day RM to a 124-day RM.[3] (Note that these 'Relative Maturities' are indeed relative, as corn possesses some day-length sensitivity—in other words, moving a hybrid or inbred from south to north changes its maturity beyond what you would predict just based on heat-unit accumulation.) Corn varieties grown in some areas of Mexico and central America (the birthplace of corn) have even longer maturities. Breeding efforts continue to adapt corn to more northerly climates, such as the extremely short-season (70-day) CanaMaize. And again, the variation isn't confined to adaptability—we also have lines with yellow grain and those with white grain, not to mention flinty types, sweet corn, and popcorn—again, all versions of just one species, *Zea mays*.

Catch-22: We don't get intensive breeding efforts until a crop is widely grown in the area, but it isn't grown because available varieties aren't well adapted.

Could It Have Been Otherwise?

So how did we ever end up with wheat that grows well in Kansas, or corn that grows well in Minnesota? Intensive breeding efforts. How did we get the intensive breeding programs? By growing the crop. Circular, isn't it? A catch-22. Farmers must have grown a crop over a wide area to have attracted the attention of universities and private companies to get them rolling on breeding projects. Very few breeding projects garner much effort or support *until* that crop is common in the area, desirable as it may seem to do it the other way around.

So how did we get to where we are? Mostly historical accident—in other words, luck. Somebody introduces a crop into an area not so dissimilar from where the seeds originated, and it grows well enough to capture everyone's fancy, and off you go: new crop in the area, farmers and local seed companies do some early selection work, new breeding program at the local land-grant college, more seed companies get involved, etc. The crop is now established in everyone's mind and the breeders' budgets, and people start thinking of it as having always been there.

Sometimes the species (or variety) being introduced is hardly adapted at all for that area, but perhaps due to a lack of other cropping alternatives (and a lack of good transportation in the early days) the crop becomes established in that area. Quite often the choice is determined by cultural factors—everyone was accustomed to eating that crop, and growing it, so the emigrants took it with them and planted it in their new colony, regardless of how poorly it did in the new climate. After a few dozen generations of mostly inadvertent selection (by planting back the seeds of the plants that happened to be slightly better adapted to the new climate than were the others in that seed lot), the yields often became halfway

Photo by Matt Hagny.

Corn was once the predominant crop in Kansas and Oklahoma. After languishing for many decades, the crop is regaining importance on the southern Plains.

[2]Despite what Kansas vehicle tags have said for so long, Kansas really isn't the wheat state—it's a miracle the stuff grows here at all. Wheat was first domesticated in the Mediterranean climate of the Fertile Crescent, where Iraq, Syria, Jordan, and Turkey are today, and is better adapted to those extremely mild winters with a very gradual warm-up. Indeed, wild stands of these cereals (close cousins of our wheats) will typically yield grain of over 15 bu/a, all without an ounce of human effort or investment until the day of harvest!!

[3]Growing corn in North America is nothing new: the native peoples have been growing corn extensively in the U.S. for *over 1,100 years*, everywhere from the arid highlands of New Mexico & Colorado, to Ohio, to the Eastern seaboard. Archaeological evidence shows corn was grown in what is now Tennessee and Ohio as early as 1,700 years ago. Dry beans and cucurbits were also common. Interestingly, some of our most problematic weeds—pigweeds and waterhemp (*Amaranthus spp.*)—were also early domesticates grown for grain. (from Bruce Smith & Paul Minnis, 1992, in *The Origins of Agriculture*, ed. C. Wesley Cowan & Patty Jo Watson, Smithsonian Institutional Press.)

respectable. This is how wheat really got going in Kansas and Oklahoma: it became popular at a time when corn (the prevalent crop in Kansas and Oklahoma back then, see chart) was faltering in a series of slightly drier years and just when the soil was losing its ability to support corn due to the loss of OM following 30 to 40 years of tillage. Wheat and other winter cereals were truly minor players up until then, with Oklahoma having ten times more acres in corn than wheat as recently as the late 1890s. Perhaps an indicator of how poorly it was suited to the climate, wheat was first introduced to N. America quite early by the Spanish settlers but never really caught on. The introduction of the 'Turkey Red' wheat variety by the Mennonites came at just the right time and circumstances to catch hold.

The trick is to find reasonably well-adapted crop species from distant lands and import them but not the bugs.

In another historical accident, soybeans were first introduced to the U.S. as a forage that was easier to manage than cowpeas (less vining, more erect plants worked better with existing haying equipment). Only later were soybeans bred for grain, due in large part to certain people, such as Henry Ford, championing their cause (although the grain of soybean had long been harvested in their homeland of SE Asia)—the corn >>soybean rotation of the U.S. Corn Belt almost wasn't.

Back to the Future

Look at how acres have shifted in Kansas & Oklahoma, from considerable diversity to a preponderance of wheat (see chart). The charts don't capture all the swings over the years: in the 1890s, Oklahoma was growing 2.5 to 3.0 million acres of corn, but only a few hundred-thousand each of wheat and oats. The big shift to wheat occurred from 1910 to 1920. The trends are shifting again, hastened by the less-restrictive '96 U.S. Farm Bill and recent increased adoption of no-till: dryland corn acreage in Kansas has rebounded, and soybeans are gaining popularity. Recent 'discoveries' of cotton, spring

Where Do We Go from Here?

Oklahoma Crop Acreage (Harvested)

	1909	1997
Corn	5,900,000	200,000
Cotton	2,000,000	200,000
Alfalfa	400,000*	400,000
Soybeans	0**	300,000
Sorghum/kafir	500,000	500,000
Oats	600,000	0
Wheat	1,200,000	5,400,000

Source: Okla. Ag. Statistics Service

Note: all acreages rounded to nearest hundred-thousand; if '0' then less than 50,000 acres.

* from 1919 (first year alfalfa data recorded).

**No data. Some were grown for hay during those years, but generally not for grain.

Kansas Crop Acreage

	1910	1998
Corn	8,600,000	3,000,000^
Alfalfa	900,000	1,000,000
Soybeans	0**	2,500,000
Sorghum/kafir	1,200,000	3,400,000
Oats	1,700,000	100,000
Barley	300,000	0
Flax	100,000	0
Spring Wheat	100,000	0
Winter Wheat	4,800,000	10,100,000

Source: Ks. Ag. Stats. Service

^ Corn acreage would have fallen even more dramatically during these years were it not for the widespread adoption of irrigation in the western part of the state during this timeframe.

**No data. Some were grown for hay during those years, but generally not for grain.

wheat, and cowpeas growing well here is nothing new; these crops were rather common during the late 1800s. In addition to the crops listed on the chart, records from the 1870s and 1880s for Harvey and Sedgwick counties (of KS) indicate that many other crops were successfully grown, including tobacco, castor beans, buckwheat, millet, timothy, clover, soybeans, and vegetables.

Economics dictated much of the shifting away from this diversity, especially if we broadly define economics to include things like new technologies and the whims of politics. Access to cheap transport during the last century and a half has radically altered (expanded) ag markets, and concentrated production in areas with competitive advantages.

Genetics are very malleable, and plant selection (intentional or otherwise) works wonders at 'fine-tuning' a species to an environment, so well that we often inadvertently select against traits we probably should be keeping.

Refrigeration also. On the international side, the export markets are driven by such things as politics (inscrutable), currency exchange rates, and foreign supply & demand (again, subject to the vagaries of history, such as population growth, food preferences, business climate, attitudes, and political stability). On the more local level, input prices and yields are sometimes dramatically changed by some new technology, such as synthetic fertilizers, herbicides, mechanization supplanting hand labor and horses, hybridization, etc. Subsidies and insurance availability also play major roles. Many other factors often enter into the equation, often chalked up as wacky historical accident—things like Ford's fondness for soybeans, or a series of crop failures or shortages due to weather cycles or pests, or a new consumer trend.

Photo by Matt Hagny.

Corn hybrids commercially available in the U.S. aren't particularly well adapted to Kansas and Oklahoma, despite corn originating in southern Mexico—nearly all of the breeding work done in the last century has focused on milder climates.

The crops grown in an area quite often aren't native to that place —they're brought in from somewhere else. Usually the native species, while very highly adapted to the soils and climate, are also susceptible to too many insects and diseases already common in that location.[4] The trick is to find reasonably well-adapted species from distant lands and import them but not the bugs.[5] Then let the breeders work at making the crop even better adapted.

Genetic Sculpting

So, what might things look like, had we pursued breeding wheat lines for Iowa and Illinois as zealously as we did breeding corn for those conditions? And what if we hadn't abandoned breeding corn for the southern Plains? Things might look very different (like, we would have corn well adapted to Oklahoma & Kansas, and wheat might actually be commonplace in Illinois). And I would suggest that finding corn, soybean, and cotton genetics better adapted to Kansas will do a lot more for Kansas farmers than continued over-emphasis on wheat breeding (and lots of the traits we're feverishly breeding into wheat wouldn't even be necessary if we had good

[4] Granted, the native species have also evolved many defenses against the native pests, but they also expend lots of precious resources for those defenses—resources we humans would prefer to divert to larger yields of grain, forage, or fiber.

[5] While rather successful throughout agriculture's recent history, there's no guarantee that local pests won't adapt, or old ones from the crop's homeland won't accidentally get introduced. Despite the potato's origin in the S. American highlands, and its phenomenally successful introduction into Europe, late blight (*Phytophthora infestans*) devastated the European potato crop starting in 1841. Northern Europe, particularly Ireland, had experienced a human population explosion as a result of the potato's widespread adoption and had become heavily dependent on it to support the people. The devastation of the potato crops during those years resulted in mass starvation, including over a million deaths in Ireland alone, and many millions emigrating to the U.S. (from Jack Harlan, 1995, *The Living Fields*, Cambridge Univ. Press.)

rotations, and more no-till). Similarly, the folks in Illinois and Ohio need improvement/development of wheat, alfalfa, industrial hemp or some other crop much more than they need improvement in soybeans and corn genetics. But, due to historical accident, they likely aren't going to get it anytime soon (or even realize what they don't have).

There are several conclusions that can be drawn. First, the reason a crop is grown in an area probably has as much to do with historical accident as it does with that crop being intrinsically well-suited to that location. Second, genetics are very malleable, and plant selection and breeding (intentional or otherwise) works wonders at 'fine-tuning' a species to an environment.[6] In fact, it works so well that we often inadvertently select against traits we probably should be keeping (but that is a story for another day). Third, as we look around for crops to diversify our rotation, we should not be too easily discouraged if they aren't an instant success—accidentally getting the right variety for a locale is unlikely right out of the gate, not to mention getting the agronomy halfway right for that crop. This is especially true when the new crop is put up against crops that have been bred for the area for decades, if not centuries or millennia, and for which the proper agronomy is common knowledge. Along those same lines, 'escaped' introduced plants sometimes really take hold and become problem weeds (e.g., kochia, 'cheatgrass,' bindweed, Johnsongrass), but the majority of introductions are poorly adapted and quickly die out (we only notice the ones that *don't* die out). Fourth, there is historical precedent for great crop diversity in KS and Oklahoma, not just the winter wheat that so dominates our thinking. And, even if there wasn't a precedent, we should be working on diversifying our portfolio of crops and our understanding of their place in a rotation. Nature is relentless in trying new variations, always searching the space of the possible. Nature never stops looking for improvements, and neither should we.

Nature is relentless in trying new variations.

[6] Lest we get too proud of our breeding programs, Jack Harlan reports an experiment started by his father, H.V. Harlan, in 1928. He chose 28 diverse barley varieties out of his collection of 6,000 and crossed them in all possible combinations, for a total of 378 in the F2 generation, which were then mixed as evenly as possible and planted in an increase block, and eventually sent to several experiment stations to be grown year after year without any further (human) selecting. At UC Davis, it had been grown for over 60 generations by 1995. Yield improvements were dramatic during the early years, before settling down to more gradual increases. Most interestingly, yields kept pace with 95% of the best lines that barley breeders could achieve during that time with deliberate breeding efforts. (Harlan, 1995.)

Notes on 'New' Crops

Most of you know something about producing wheat and corn and merchandising the grain. In an attempt to regain diversity, many other crops are being grown or tried that are less familiar, or were completely unheard of until recently, and so the confusion sometimes runs deep. While a far cry from a complete agronomic reference, here are some of the basics on just a few of these 'new' crops:

Chickpeas (*Cicer arietina*) a.k.a. garbanzo beans: b-lf legume, planted early (earlier than corn) and ripen shortly after wheat (originated in the Mediterranean climate of the 'Fertile Crescent,' wild relatives of chickpea occur only in SE Turkey), tolerate dry weather and high-pH soils, grain targets human-edible market and requires certain color and size to capture the $ premiums (different requirements for 'kabuli' and 'desi' types), rainy weather at maturity results in discolored grain suitable only for livestock, seed costs high, considered a 'veggie' under the '96 U.S. Farm Bill (can only be harvested for grain on non-base acres).

Dry beans or field beans (*Phaseolus spp.*): b-lf legume, wide array of types and varieties with different markets and growth habits (tepary, lima, pinto, navy, red kidney, Black Turtle, G. Northern), grain targets human-edible market, many types adapted to warm dry conditions, native and longtime domesticate of Central and S. America.

Canadian field peas (*Pisum sativa*) a.k.a. spring peas: b-lf legume, planted very early (like oats or spring wheat) and mature about the same time as wheat (like wheat, peas are another 'Fertile Crescent' Mediterranean native), need to finish before hot weather for good yields, can be harvested for grain for livestock or as a forage.

Austrian winter peas (*Pisum sativa*): planted in the fall (like winter wheat), used primarily for a cover crop in this part of the world, seed costs rather high, very limited time available in the fall when temperatures are conducive to growth, spring regrowth slow—perhaps due to winter injury.

Cowpeas (*Vigna unguiculata*): b-lf legume, tropical in nature (native to central African savanna, *Vigna* genus also thought to be native to SE Asia), need very warm soils for ger-

mination, often used as a forage although not palatable until pod-fill, grow much faster than soybeans under hot dry conditions, grow well in low-pH soils, were once rather common on the southern U.S. Plains and many varieties exist with very different maturities and vining propensities, grain yields superior to soybeans in tough hot dry environments but considered a 'veggie' under the '96 Farm Program (cowpeas are the same species as black-eyed peas). Mung beans (*V. radiata*) and *adzuki* beans are in the same genus but have origins in SE Asia, human-edible market, mung beans tolerate warm dry conditions much like cowpeas.

Sunn hemp (*Crotalaria juncea*): b-lf legume, tropical in nature (native to India), needs very warm soils like cowpeas or cotton, primarily used for a cover crop (many, but not all, varieties are poisonous to livestock) and produces tremendous biomass in a short time with hot weather and adequate moisture, suppresses weeds rather well, *not* at all closely related to industrial hemp (*Cannabis sativa*) or marijuana ('hemp' is a categorical word for tall fibrous plants, much like 'cereal' encompasses diverse grass plants harvested for grain), tolerates low-pH soils, needs cowpea-type inoculant.

Hairy vetch (*Vicia villosa*): b-lf legume, cool-season (Fertile Crescent origins again), main use as a cover crop that will overwinter (sometimes), won't tolerate high temperatures, stand establishment somewhat erratic. Many other species and subspecies of vetches are domesticated, bigflower vetch (*V. grandiflora* cv Woodford) reportedly is one of few more winter hardy than hairy vetch.

Lupins (*Lupinus spp.*): b-lf legume, most varieties need acidic soils, domesticated independently in the Fertile Crescent and in S. America, some *Lupinus spp*. also native to N. America.

Lentils (*Lens culinaris*): b-lf legume, cool-season habit (Fertile Crescent domesticate), primarily grain for human-edible market, but seem to work well as a cover crop when thin stands are grown amongst sunflowers to prevent wind erosion after 'flower harvest (planted at the same time as the 'flowers).

Cotton, 'upland' type (*Gossypium hirsuta*): non-legume b-lf, tropical domesticate (origins in lowlands of Central America & Caribbean, although the *Gossypium* genus is very old and widespread worldwide).

Canola (*Brassica napus*): non-legume b-lf, oilseed, both winter hardy and spring types exist, prefers cool temps. for maximum grain yields and reducing shattering, may be useful as a cover crop due to low seed costs and ability to fit into many different seeding windows, also highly nematocidic (kills nematodes), a host to white mold (*Sclerotinia sclerotiorum*), native of SE Asia. The *Brassica* genus also includes turnips, cabbage, kohlrabi, and broccoli, as well as the mustards.

Oilseed radish (*Raphanus sativa*): non-legume b-lf, same species as the common radish, not so distantly related to the *Brassica* genus.

Editors: The preceding notes are intended only as the briefest introduction. Enormous differences will occur as to how varieties of any of these species respond to management, soils, and climate. Experimentation and caution are always advisable, although we seriously doubt many replicated studies were conducted before wheat was widely adopted on the U.S. Plains —whatever works, works.

Photo by Doug Palen.

Cowpeas planted after wheat harvest. Cowpeas were once rather common in eastern Kansas and Missouri, and produce high-quality hay.

Calendar

June 27
Dakota Lakes Research Farm's Annual Field Day

July 24
Saline Co. (KS) No-Till Field Day, Ritchie Tarn Farm

August 5-7
South Dakota No-Till Bus Tour

August 14
Dickinson Co. (KS) No-Till Field Day

August 16
Rice Co. (KS) No-Till Field Day

Inoculants Are Alive!

While many of the crop input products you handle during the year are relatively simple and stable chemical compounds, inoculants actually contain living organisms—inoculants are highly concentrated with specific strains of *Rhizobia* bacteria in various carriers of liquids, peats, powders or granules to promote bacterial survival and ease of handling. For maximum legume yields, you want all of these helpful bacteria to survive until they are installed in the soil along with the seed.

Many *Rhizobia* species exist, and each *Rhizobium* species typically forms symbiotic relations with only one particular species of host legume, or, at most, several related species of legume. For instance, the *Rhizobium* for alfalfa does nothing to colonize soybean roots. Likewise, the *Rhizobium* for soybeans won't colonize cowpea roots. If a field has never had a particular *Rhizobium* introduced (and it isn't native to that locale), then good inoculation is imperative—take no chances!

Without Rhizobial colonization, the legume plants will be N def., and (predictably) slow growing and low yielding. When planting a legume species for the first time in a field, get inoculants from a couple different suppliers to ensure that at least one batch is viable (sometimes inoculant is handled improperly during shipping or storage)—you need high counts of viable *Rhizobia* delivered to the soil, since it is definitely a 'numbers game.' Once the inoculant is in your possession, take care of it. High temperatures kill off inoculant quickly, as will sunlight. Mixing inoculants with chlorinated water is another good way to kill all the *Rhizobia*—use water from a well, or distilled. Thawing frozen inoculants in a microwave oven is yet another way to make them very dead. Some seed-applied fungicides are also extremely good at killing off your inoculants. R.I.P.

Photo by Doug Palen.

Ray Ward checks the nodulation of sunn hemp during the '01 No-Till on the Plains Kansas Bus Tour.

Photo by Matt Hagny.

For legumes, having enough of the proper *Rhizobium* in the soil is important! This field of soybeans had a high-quality inoculant applied to the seed. However, the pale six-acre strip in the middle of photo had never been in soybeans previously; on either side, soybeans had been grown *once* before—27 years earlier! (Forget what you've been told about *Rhizobia* not living in the soil for more than a couple years.)

South Dakota No-Till Tour 2001

by Matt Hagny

When we started the SD No-Till Tour in 1995, most of Kansans who took the Tour were wide-eyed newbies to the concept of no-till. At that time, not many Kansans were even remotely receptive to the idea, let alone trying any (although even back in '95 there were indeed a few around the state who had actually been 100% no-till for several years). By 2001 the group was different. While we still had a high number of those just getting acquainted with no-till (no surprise—no-till isn't quite mainstream here, yet), there were also significantly more who had substantial no-till experience. Some exceptionally astute questions and ideas flew back and forth the entire trip—we are not all rookies anymore. It is a great deal of fun to assemble the more advanced no-tillers, the deep thinkers, to hash over successes, problems, solutions, and new ideas. We hope we never stop improving.

As with the 2000 Tour, this one went remarkably smoothly. Our first stop was Ward Laboratories in Kearney, NE. After a tour of the soil lab, we 'kidnapped' the lab's founder, Ray Ward, and took him along for the rest of the bus tour. Ward is very knowledgeable not only in soil testing procedures, but also in practical aspects of nutrient management in no-till. We thoroughly enjoyed his insights and sharp wit. At one point, while driv-

ing through the irrigated corn and soybeans of Nebraska, someone asked what was the most limiting

factor for that area. Ward stood up, said one word: "Management," and sat back down. Succinct and enlightening—Ward at his best.

Making It Work

The first farm stop was Steve & Todd Taylors' near Presho, SD. Steve's son, Todd, manages the farming operation, although Steve is very involved and knowledgeable. Taylors began no-tilling in 1988 and have been 100% since '94. Under tillage-based farming, the surrounding area was almost exclusively in a winter wheat >>summerfallow rotation, although lately w.wht >>corn (or milo) >>fallow has become popular. Upon converting to no-till, Taylors also used this w.wht >>corn >>fallow program. A few years later, their rotation had become spring wht >>w.wht >>corn >>sunflowers (the summerfallow was gone). 'Cheatgrass' became a problem, and wet spring weather sometimes made corn planting nearly impossible in the heavy wheat stubble. Consequently, Taylors started putting proso millet into some of the 'stacked' (2d-year) wheat stubble, and some of the corn now goes either into millet stubble or sunflower stalks. Taylors are beginning to wonder if canola dormant-seeded (during the winter) into the wheat stubble would avoid the problem. Corn would then be planted into the canola stubble. Taylors are also doing an oat/pea mix for hay, which is an excellent transition to w.wheat for their area. It is debatable whether having the spring pea in with the oats is desirable or not —the increase in hay value is minimal and there is some concern of the pea carrying some b-lf diseases.

One of the biggest problems Taylors face is planting in the spring into their sticky clay soils (Promise clays

—some of the toughest anywhere). The planting window for summer cropping is relatively short, and the spring is often rainy. The most fundamental obstacle is simply getting the planting equipment to function in such conditions—Todd can often get the tractor across the field, but the mud packs into the opener and stops everything up. We kicked around various ideas to remedy this, including using a gauge wheel made of poly or brass that would better resist the mud's tendency to follow the opener blade out of the furrow (the wet clay adheres so tightly to the blade that the soft rubber gauge tire lip is powerless to hold it down, which then proceeds to pack inside the gauge wheel, eventually stopping it, regardless of what scrapers are used or how tightly the gauge wheel is shimmed against the blade).

Taylors have also had a few problems with sunflower stalks blowing during fierce Chinook winds—the situation is especially bad if the field has been seeded to wheat, which flattens the 'flower stalks and results in the drill openers further loosening the soil surface. Dwayne Beck seems to have solved this, however—more on this later.

Other than the issues mentioned, Taylors really like the reduced overhead and risk management afforded by no-till. Overhead is really low, with Todd getting over 4,500 acres/year with 30' of JD 750 drills and a 12-row planter. They also do all their own harvesting and spraying (for many years, Todd did it all with a 220 Spra-Coupe!). Their low overhead is made possible by the workload spreading of diverse rotations. Taylors are more profitable with no-till and say they will never go back to doing tillage.

Photos by Doug Palen.

The 7th annual SD No-Till Tour definitely got us out in the field! Looking at long-term no-till production and research in South Dakota, the Tour's participants were in various stages of no-till adoption in Kansas, Oklahoma, Texas, and Nebraska.

Reinventing No-Till

After Taylors, we traveled to Dakota Lakes' West River rotational study and did a quick walk-through. The site has been in 17 different rotations (in replicated plots) for 10 years. As the wheat and other winter crops had just been harvested and the stubble not yet sprayed, we could easily pick out big differences in weed pressure, which was a direct result of the rotation used in that plot. The short rotations were having trouble and in need of major intervention (read: expensive technology) to keep them from collapsing, although the ultra-low-disturbance methods were indeed helping the situation by maximizing the degradation of weed seeds left on the surface—viability is quickly lost by predation, decomposition, etc., when left on top. Taking a look at the yield and profitability data from the W. River site confirms the need for long rotations.

The corn was looking quite good this year at the W. River site—amazing what 10 years of no-till had done to change the soil there. On past tours, we have sometimes compared the soils and crops of this site with adjacent fields under tillage regimes—the differences were shocking.

Steve & Todd Taylor really like the reduced overhead and the risk management afforded by no-till. Profits have improved also.

The next day, we spent the morning and early afternoon with Dwayne Beck at Dakota Lakes' Main Site (E. River) touring the rotational studies (yields and costs for each rotation are available at dakotalakes.com). Both irrigation and dryland blocks are included at this site. Beck introduced nightcrawlers to the irrigated portion of the farm back in '91, and these have colonized the soils very well, forming many vertical burrows that extend about 4 feet down. These burrows, along with no-till, have radically changed the characteristics of that soil: we walked in immediately behind a lateral-move irrigator that had just applied 3 inches of water less than 5 minutes earlier—we came out of the field without a trace of soil sticking to our shoes!

Yield and profit data from Dakota Lakes confirm the need for long rotations.

On the irrigated side, we looked at Beck's Japanese millet seeded a couple days prior, right after the wheat was harvested in the field (central SD is pretty far north for double-cropping). This millet was eventually taken for hay, and the field will go to soybeans next year.

On the dryland side of the research farm, we looked at a variety of crops, including chickpeas awaiting harvest. In the sunflowers, we observed a sparse scattering of lentils amongst the 'flowers; the lentils don't really compete with the 'flowers, but do serve to protect the field from strong winds during the winter, since the bushy lentil isn't nearly so fragile as the 'flower stalks (a simple, elegant solution, eh?). We also walked out into a plot that has *never* been tilled, originally a corner of the farm thought too steep and too thin of a soil to be used for cropping. Beck killed the native sod chemically in the mid-90s and has been cropping it ever since. We admired the feel and smell of the soil in this plot (Ward had his beloved spade along), which was still remarkably different and better than the adjacent plots that had been in no-till for only 10 years. Yields, too, are dramatically better on this ten-thousand-year no-till plot, even though it was once considered too poor a soil to even be farmed (and it is a north-facing slope, to boot). To answer the question of how long it takes for soils to recover productivity under good no-till management: more than 10 years. (And these SD soils were hardly the most abused soils in the world while under a tillage regime.)

We also looked at Beck's Concept Seeder, which had undergone major surgery yet again (I've been watching it morph for 5 years now). Most of the changes lately have been to the opener. Each seed opener now has its own parallel link and its own hydraulic down-pressure cylinder, with a dedicated fertilizer opener attached directly to the front of each seed opener. A single-wheel residue manager rides between the fert. opener and the seed opener. The seed opener is a single 18-in. blade at 5-degrees, with a 3-in. gauge wheel alongside. The boot (seed-tube guard) was fashioned from a Flexi-coil FSO seed boot and is narrow enough to stay in the 'shadow' of the blade. A narrow vertical wheel (from an SDX) runs in-furrow to firm the seed into the bottom of the 'v,' followed by a depth-limited spoked closing wheel that shatters the sidewall. After witnessing all the permutations over the years, I think this one is really really close; I expect it's only a matter of time before some of these design elements come to market (we're

Photo by Doug Palen.

Longtime no-till producer Steve Taylor discusses dryland corn production at his farm north of Presho, SD.

already seeing a couple manufacturers adopting the bridge-frame idea).

Building on Success

After a quick stop at Dakota Lakes' new North Unit (which will replace the W. River site), we set out for Ralph Holzwarth's farm near Gettysburg. Ralph's soils are glaciated and considerably nicer to work with than Taylors' area (but priced accordingly). We admired Ralph's corn, which was looking really nice. (He always has nice corn—Ralph has been a Tour stop 6 out of 7 years. Thanks, Ralph!) Ralph has been 100% no-till since 1992, and his rotation during much of this time has been spring wht >>w.wht >>corn >>sunflower (or soybean). Occasionally he adds some proso millet. The 50% wheat in the rotational plan of 2-in/2-out worked for a few years, but Ralph reports increasing problems with 'cheatgrass' and is moving toward lengthening the break between wheat crops, probably by doing corn two years in a row. (I had asked Ralph several years earlier if he would ever consider doing 'stacked' corn, to which he replied that he didn't have enough moisture, so it was interesting that he was now willing to try it.) Someone also brought up the possibility of expanding rotations with an oat/pea mix for hay, which Ralph thought had merit: the oats or oat/pea mix would follow his sunflowers or soybeans, and would nicely transition to wheat. Ralph noted that back in the early '90s he usually had at least one field of oats somewhere, and that the wheat after the oats always was some of his best. Ralph also discussed the success he was having with split applications of N on his wheat, sometimes boosting yields by 20 bu/a versus having the total applied in a single early application (Ralph's research methods are very good, and he claims the only problem with GPS-based yield mapping is that "you go crazy testing all these different things"). He uses a stream bar on his sprayer to apply liquid N in the wheat.

Ralph is having good success with soybeans in the rotation, a crop that was almost unheard in his area a few years ago. One of the problems they've encountered is getting sufficient loads of *Rhizobia* out in fields that have never seen a soybean before. He's been using a higher priced granular inoculant in his JD 1860 air drill, which seems to help overcome this problem. While we were discussing these things out in Ralph's soybean field, Ray Ward was busy digging to examine root development. Apparently we talked too long, as Ward soon had dug a pit worthy of a backhoe!

We next stopped at Ralph's headquarters to look at machinery. Ralph's management style can be summed up as 'keep it simple'—yes, he looks carefully at all the details, and is very willing to do the extras if the financial rewards are there. But, in Ralph's opinion, too much of that stuff is just extra "goofing around," and he sees bigger rewards from pushing his existing machinery a little farther, or putting extra effort into crunching his financial numbers. This attitude carries over into machinery purchases. In Ralph's words, "I want to go to the local dealer, get what I need, and get back to work." He runs a stock 1860, and a 16-row Deere planter that is stock except for residue managers, Keetons, spoked closing wheels, and liquid fertilizer (the planter is actually owned by Jim, who works for Ralph as well as farming his own acres—they have a unique business arrangement spanning decades). Ralph recently bought a used Patriot self-propelled sprayer (he ran a pull-type Flexi-coil before). Ralph has a semi-trailer dedicated to tending the sprayer, designed and plumbed for efficiency at mixing and filling.

Photo by Doug Palen.

Dwayne Beck opens our eyes at Dakota Lakes Research Farm (E. River).

Dave & Carol Gillen do a good job of structuring rotations with short-break/long-break characteristics, which will preserve and enhance the power of their rotations.

Gillens: Pushing the Envelope

The next morning came too soon for those of us who carried on discussions late into the night at the bar in Pierre, but we piled on the bus and headed for Dave and Carol Gillen's at White Lake, SD. Gillens have been 100% no-till for 10 years now, and have expanded their acreage considerably in the last few years. Gillens are in an area of nice glaciated soils and higher rainfall than either Gettysburg or Pierre; their area is on the western edge of the traditional corn >>soybean region. Gillens keep wheat in the rotation, however, although they are

Photo by Doug Palen.

Beck's Concept Seeder, the '01 version (changes every year, but the mutations have been converging on this design for some time now). Each single-disc seed opener has its own residue manager and fertilizer opener, and each seed opener sub-frame has its own parallel-link and hydraulic down-pressure cylinder. Now *that's* precise seeding.

reconsidering the stacked wheat that they've been doing in recent years. Gillens are trying to find a cover crop to use some of the extra moisture when going from wheat to corn, which would make the stacked wheat more workable for them. They have been working with hairy vetch, with some success, seeded a few weeks after wheat harvest and surviving until it is sprayed out at corn planting. This year, they also tried sunn hemp and sunflowers for cover crops (planted a few days after we left), although neither will overwinter. After wheat, they either go corn >>corn >>soybean >>soybean, or they'll go corn >>soybeans >>corn >>soybeans (their climate is cool enough that corn on soybean stubble is workable). Gillens do a good job of structuring rotations with short-break/long-break characteristics, which will preserve and enhance the power of their rotations.

Dave was lamenting the lost yield potential on his corn, which had less than an inch of rain since the first of June (seedling stage). It looked tremendous to those of us from central Kansas, where everything was already burned up in one of the hottest driest Julys ever. Gillens had lost half their potential, certainly, but it still looked wonderful. As we immersed ourselves in the field, Ward shucked an ear of corn, then pointed to the 'tipping back' at the end of the ear and asked me very solemnly what caused that. I answered "Drought," wondering to myself where he was going with this inquiry, when Ward said, "No, the cob's too long." We got a laugh out of that, and then I off-handedly said that his answer was a tautology. Ward asked what that meant, and I explained that it was a self-referencing statement, one that is true by definition, to which he smiled and chided my fancy word: "Back in my day, the word 'redundant' was plenty damn good enough!"

Dave later reported that they'd had no rain after we left, either, and the corn still averaged 97 bu/a and the beans about 25. He also mentioned the long-term no-till fields yielded better, as did the ones with wheat in the rotation.

Gillens' corn is on 22-inch spacing put in with a White 6000-series

Photo by Doug Palen.

Concept Seeder, firming and closing.

Photo by Doug Palen.

Ralph Holzwarth fields questions on his spraying equipment.

planter. In contrast to Holzwarth, Gillens have no qualms about modifying their machinery to gain a little advantage. Among other things, they have cut holes in the gauge wheel rims on the planter to let the mud escape. Their other equipment is a 750 drill (modified) and a RoGator (they do custom spraying) —once again we find that overhead is astonishingly low per acre covered.

The long journey back to Kansas gave us many opportunities to hash over what we had seen. A pleasant addition to the trip was Allen and Yvonne Postlethwaite, from St. Arnaud, Victoria, Australia, where they operate a sizeable cropping enterprise that has been under zero-tillage for 19 years. Together with two of their sons, they run a very successful operation (I've been to their farm). The Postlethwaites happened to be in SD at the same time as us, and arranged to join our tour and to travel to Kansas with us. On the way, Allen described to us how they got started with no-till, and the changes that have taken place since that time. It is interesting that regardless of soils or climate, no-till and good rotations carry the day.

And so our entourage arrived back in Salina, rather weary but also highly intrigued as to how we would make use of so many new ideas we had acquired in just 3 days.

Editors' Note: The Epilogue of the 2000 SD Tour is available at www.notill.org.

Systems Approach to No-till in the Future*

Dwayne Beck is manager of Dakota Lakes Research Farm at Pierre, SD.

by Dwayne Beck

PERSPECTIVE

**Originally presented at the SD No-till Association's 2001 Conference at Aberdeen, SD and included in those proceedings (edited here).*

The presentations I make are normally focused strongly on techniques used to improve crop rotations and other components of diverse no-till systems—all of this material can be found at our website (www.dakota-lakes.com). In this presentation, I will attempt to share our thoughts on another recurring question: why the Dakota Lakes Research Farm has put so much emphasis on developing the systems approach and what it tells us about the future.

The track record of meteorologists and stock pickers in the last year demonstrates the danger of prognostication. Consequently, readers should interpret the contents of this paper with a great deal of skepticism. The author reserves the right to be wrong (and hopes you forget). He also hopes to have the ability to gloat if some of this material is prophetic.

The Systems Approach

The terms 'system,' 'systems approach,' 'holistic management,' etc., have become quite popular during the last few years. This signifies an increasing awareness that management decisions and policy techniques need to be based on a broader perspective than has been common in the past. This awareness has developed as the result of continued frustration when seemingly good management decisions and sound policy lead to totally unexpected consequences. The logic is that, if seemingly good decisions consistently lead to bad or unanticipated consequences, either the decision makers are incredibly stupid or the techniques used are flawed. Maybe there is a little of both involved.

Being aware that approaches used in the past have problems does not provide solutions to those problems or even indicate where the methods were flawed. And simply espousing the need to use a systems or holistic approach does not indicate how it should be done. Similarly, when it is stated that a systems approach has been used, this does not necessarily mean that it has been used correctly.

The validity of decisions made using a systems approach must (by definition) be based on evaluation of the impacts these decisions have on the components of the system and the system as a whole. Several excellent texts are available outlining this way of thinking and how it is developed and implemented; this paper will not try to compete with them in providing the basics. However, since most of these have not specifically focused on issues surrounding crop production or no-till, we will attempt to apply some systems analysis techniques to predicting what the future holds in store.

Photo by Doug Palen.

Commodities or products? —some insights.

Basic Premises

Before making any predictions it is important to outline some basic 'principles' upon which they will be built. Obviously, if these are not correct the predictions will be flawed.

Perception is reality. It is not certain that the 'real truth' ever triumphed over 'perceived truth' other than in old movies. There is no reason to expect this to change in the future. In fact, as the complexity of issues increases (e.g., global warming, carbon sequestration) it becomes difficult for even the knowledgeable well-intentioned individuals to agree on what is the truth. This is complicated even more by the willingness and ability of special interest groups to impact public perceptions. Consequently, even when the truth *is* known, it isn't important unless efforts are made to assure public perceptions are the same.

Even when the truth is known, it isn't important unless efforts are made to assure public perceptions are the same.

No one has your best interests in mind except you. It is very common for politicians, bankers, government agencies (CES, NRCS, USDA-ARS,

ABS), and company representatives to infer that they have your best interests in mind. They (including me) lie. They (we) have your best interests in mind only if your interests happen to coincide with theirs (ours). This should not surprise you. It does not make them immoral or unethical. Their first responsibility is, as it should be, to themselves and their organization. Your first responsibility should be to yourself and your family or organization. How many times have you bought ag chemicals, fertilizers, or machinery because it would be good for John Deere, Monsanto, or the Co-op? Never. Why should they be any different?

It's the Economy, Stupid. The laws of economics, like the laws of nature, work exceptionally well. Economic systems, like natural systems, will shift to relieve or offset a stimulus applied to them in a consistent and predictable manner. Agricultural subsidies and import tariffs eventually become capitalized into the price of land and other agricultural inputs—they then become subsidies to landowners and major corporations, not to crop producers. If (when) the subsidy or import tariff is removed, the producers find themselves in dire economic straits until land and input prices respond to the new reality (U.S. sugar beet producers are an example). Similarly, excessive taxes and regulation on ag production would eventually lead to lower land prices, as well as reducing production by causing fewer inputs to be used.

Improved methods or new technologies are only an economic advantage until the newfound efficiency is capitalized into the price of land and other production inputs. After this happens the new techniques become necessities. No-till has raised (or will raise) the price of land in South Dakota to a point higher than it would have been without this technique. Established farmers who own a substantial land base can continue to operate and even expand without using no-till because they do not have to pay full land costs on all their acres. New producers will not be able to cash flow land purchases without using no-till or some other production system that gives them an advantage over traditional techniques.

Similarly, developing an improved product that commands a higher price from the buyer is only important until others also develop the same or similar products. Then it becomes a necessity to provide the improved product (it is no longer possible to sell the unimproved product). An example is farm machinery. How many people would buy a tractor without power steering?

Farmer-owned processors must be as efficient as privately owned ones. This means obtaining the raw material at competitive prices. Trying to make up production deficiencies by adding value in processing will not work.

A few of us remember when power steering, cabs, air conditioners, etc., were innovations.

Adding value starts with low-cost inputs. The ultimate consumer of agricultural products is becoming much less concerned about the cost of the finished product and more interested in perceived value. If you don't believe this, go shopping with my wife. Convenience, consistency, food safety, wholesomeness, and other factors have become much more important than price. Processors of agricultural goods are interested in buying quality raw materials (inputs) as cheaply as possible so they can maximize their profits. (You do the same thing: when was the last time you offered to pay more than the co-op was asking for fertilizer in order to assure they were making enough money?) Owning processing capabilities will only be important if you create a 'valuable' product from raw material produced in an efficient low-cost manner. In other words, farmer-owned processors must be as efficient as privately owned ones. This means obtaining the raw material at competitive prices. Trying to make up production deficiencies by adding value in processing will not work.

There are no miracles. We are not going to get rich growing pharmaceuticals, or with carbon sequestration payments, or other blanket subsidies.

There are no miracles. We are not going to get rich producing drugs and pharmaceuticals. The quantity needed is too small. The requirements will be too high. And the value will be capitalized into land costs in the area where the companies choose to grow the product.

Carbon sequestration payments present more potential problems than promises. Even if other countries agree to allow use of this approach, the only people who will make substantial amounts of money from it will be lawyers, bureaucrats, and land owners. It will become another subsidy. It will be almost impossible to administer fairly. It will focus attention on other greenhouse gasses released by agriculture (ammonia, nitrous oxides, etc.). It will produce more regulation. We will have difficulty being competitive with other areas of the world (and U.S.) in sequestering carbon.

Agricultural production isn't important. Politicians (including those that run farm organizations and lobbying groups) like to tell farmers they are important because they feed and clothe the world. That is true, but nobody cares. If you didn't do it, someone else would be happy to take your place. From an economic standpoint, production of raw agricultural products is almost irrelevant. Bill Gates' net worth exceeds the total value of agricultural production in the United States many times over (not as many times today as it was a year ago, but it still is many times).

Agriculture is important economically in terms of the amount of value generated by the final product, not the raw material. Agriculture is important in how it impacts the environment. This is not so obvious in sparsely populated South Dakota, but the fact that much of the legislation affecting ag producers is passed more on environmental grounds than on social and economic concerns should serve as our wake-up call.

Photo by Doug Palen.

Carbon credits and environmental incentive payments may not be in the best interests of producers, but no-till farmers are still well positioned to grow crops very efficiently, and may be able to convince consumers to pay a premium for food grown in this more wholesome and environmentally friendly way.

The Future

Technology will be a tool, not a solution. Technology has often been used to treat symptoms that should not occur in properly designed agricultural systems. In other words, technology has been used to *replace* management and cultural practices rather than augmenting them. In the future, technology for food production will become more expensive both in economic costs and also from a public relations standpoint. This does not mean that technology will not be used, but rather that it will become increasingly important to be sure that it is used appropriately: to increase the value of the product to the consumer, not to reduce the cost. Remember, the cost is not important to the consumer.

The technology that will probably have the largest impact on agriculture may be in the electronic sector, not the biological sciences. This does not mean that biological technology will not be important but rather that the ability to market directly to consumers using the Internet, the capability to manage inputs accurately on a site-specific basis, and other electronically based technologies may allow us to utilize the biological technology to its full potential.

Commodities versus products. Some farmers will continue to produce commodities. Producing these commodities at the lowest possible price will continue to be the driving force for these people. This means they will need to be extremely efficient. Appropriate farm size, crop diversity, technology, etc., all play a role in that equation. Other growers will focus on making products that have enhanced value to the targeted consumer. This value will be gained as much by how the raw material is produced as how it is processed. Organic farmers have done an excellent job of convincing some consumers that their method of production is better for the environment and results in a healthier product. Both of these perceptions are wrong, but since perception is reality, they can command a higher price for their products. No-till farmers need to capitalize on the environmental benefits provided by using diverse no-till systems by selling that value to the consumer. Carbon sequestration could be part of this value. This approach means the grower gathers the increased value because it is gained by management and salesmanship not by blanket subsidy.

Farmers need to take control of their own destiny rather than waiting for others to create this destiny for them, not just in marketing their products and shaping public perception, but also in funding research.

The bottom line is that farmers need to take control of their own destiny rather than waiting for others to create this destiny for them. Value-added co-ops are a small step in that direction. They are not an end but a means. They provide sufficient critical mass to allow producers to compete with large multi-national corporations. This does *not* mean they allow producers to use inefficient production practices. If production is not efficient the raw material will cost too much and the co-op will not be competitive.

Also, producing products designed to sell into a subsidized market (sugar, ethanol, etc.) contains substantial risks.

Farmers also need to take a larger role in funding research. Research conducted by private industry is designed to serve *their* interests. Research at public institutions is designed to serve the public good. What is perceived as public good may not be good for the producer. Similarly, the research funded by commodity groups (corn, soybean, wheat, etc.) is important for that commodity, but generally is not focused on systems impacts. Getting the research you need may mean funding or doing it yourself.

The Laws of Nature and Economics Will Not Change

This is the prediction that I know will be true: economic and natural laws will not change. In the past, much effort has been put into trying to change these laws rather than on understanding how they work and how we can use this to our advantage. If we continue to try to change how these laws work through technology and legislation, we will continue to fail. If, on the other hand, we concede that we (and our farming operations) are not independent entities but rather only a part of the system, then we can begin the process of developing a niche for our operation. Not every organism in an ecosystem occupies the same niche—quite the contrary: each strives to find the thing it can do better than other organisms. No-till farmers need to do that. I do not have to list the things we do better. Other speakers at this conference have done that. What we need to do is to focus on taking full advantage of those strengths. The increasing environmental awareness, escalating energy and fertilizer prices, etc., position us very well to take advantage of the power presented by sound no-till systems.

No-Till Renaissance

by Roger Long

When talking with Windom, KS farmer Joe Swanson, it is evident that he has a high level of commitment to doing what is right. From building soil quality and doing everything in his power to eliminate erosion, to providing a better habitat for wildlife, to promoting economically and environmentally responsible farm legislation, Joe is not afraid to speak out for his beliefs and passions. Referring to tillage and monoculture, "We just can't keep doing what we've always done. It's killing our soils and it's bad for rural America." On U.S. farm policy: "One of the biggest obstacles to no-till right now is our Farm Bill. Instead of the program promoting environmentally sound practices, it encourages a grower to keep doing whatever he has been doing!" This view may be different than his peers' philosophy but Swanson is a leader, not a follower.

Swanson's willingness to break from the "herd mentality" shows up in his early experimentation and eventual adoption of no-till. "We flirted with no-till in the '70s with a modified IH Cyclo planter . . . but we didn't have the knowledge base we do now, and the cost of herbicides was not as favorable." Through the years, Joe has tried not to do any more tillage than necessary, using whatever implements and methods were available. "We had a new piece of tillage equipment that left all of the residue on the soil surface but severed the plant from its roots. Soon after the tillage trip we had a four-inch rain and had a large amount of soil erode off the field." After this incident, Joe's goal was 100% permanent no-till, which he achieved starting in '97.

"We use only 30% of the fuel we used in conventional-till, and 50% of the iron. My machinery overhead is now only $35 per acre [no harvesting equipment], so I get all of the cost savings while increasing yields."

That's not to say that converting fields from many years of tillage abuse to a healthier system is easy. "There's a hump to get over," Joe observes. Not only is the soil biology trying to adapt to a radically different system, but also the farm manager is doing very unfamiliar things and often is unsure of even what questions to ask. "We take for granted the knowledge we now have. Once you get to a level of knowledge, it becomes a 'no-brainer' —but it takes a while to get there." And during the first part of the change, the urge to do tillage is con-

Photo by Sue Swanson.

Joe Swanson planting corn into wheat/dc 'flower stubble.

stant, like an addict's strong cravings while trying to kick the habit.

But when you "get there," numerous benefits accrue. A devout outdoorsman, Joe likes the benefits no-till affords his game bird population, "We counted 9 coveys of quail on the fields that we farm—that's in a really down quail year!" But it is the economics of no-till that pays the bills and Swanson is quick to point out those positives as well: "We use only 30% of the fuel we used in conventional-till, and 50% of the iron. My machinery overhead is now only $35 per acre [no harvesting equipment], so I get all of the cost savings while increasing yields." Some economic advantages take longer to develop but are just as evident. "We had a field that was wheat and double-cropped to sunflowers, half was no-till for five years and half was no-tilled for nine years. The half that was no-till for nine years yielded 300 pounds per acre better than the five-year no-till [although the 9-yr side was a more eroded, thinner soil prior to going into no-till]. We are seeing yield increases from long term no-till."

Joe: Steady At the Helm

Many growers see the only way to bring CRP back into crop production is through tillage or burning or both—the attitude is generally: when in doubt, do more tillage. Joe saw a better way, and has twice converted established CRP fields to cropping without burning or tilling. Joe drills Roundup Ready soybeans directly into the CRP, doing nothing to prepare the field other than applying Roundup for a burndown at planting. His most successful kill of warm-season grasses, including little bluestem, has been with a single application of Roundup + Select in the soybeans. In converting one of the CRP fields, he first went with two years of soybeans, then wheat (yielding 70 bu/a) and then double-crop sunflowers, which were harvested in the fall of 2001: "We harvested 1,450 pounds per acre of sunflowers in a tough sunflower year." Joe also notes that the fields are smooth after the grass clumps decomposed, "After two years of soybeans, there wasn't a great deal of residue left."

Photo by Joe Swanson.

Swanson drilling wheat into cover crop cowpeas.

Joe's understanding of the importance of crop diversity in a productive no-till system has led him to explore a wide array of cash crops. Joe has long had milo in his rotation, and was one of the first in the area to grow soybeans (long before he converted to permanent no-till). He has tried cotton, among others. His current rotation is generally corn >>corn >>soybean >>wht/dc flowers, although sometimes two years of milo is substituted for the corn. Joe has done some 'stacking' of soybeans on several occasions, and also stacked wheat; he is moving toward doing more stacking of these crops. In addition to double-crop flowers, he's also done milo and soybeans as double-crops.

"I broke a cardinal rule last year and planted a couple hundred acres of a new corn hybrid that won my variety trial the previous year. Never choose a hybrid on just one year's results! It cost me 50 bushels per acre because it couldn't handle the heat we had last year."

Corn has worked its way into Swanson's rotation and is now an important component of his system. Swanson's best corn hybrids have been in the 118-day maturity range. 2001 was a tough year for corn in his area due to extreme heat in July and

very little rain, but it wouldn't have been so bad were it not for one hybrid that completely fell on its face. Joe comments, "I broke a cardinal rule last year and planted a couple hundred acres of a new corn hybrid that won my own variety trial the previous year. *Never* choose a hybrid on just one year's results! It cost me 50 bushels per acre because it couldn't handle the heat we had last year." He's had his share of success as well. In 1999, he took 3rd in the state in the Nat'l Corn Growers' contest in the non-irrigated, no-till division with a yield of 183.7 bu/a. "And that wasn't even the best field—we had another field that went over 200 bushels per acre." Swanson's 5-year average on corn is 98 bu/a, which is nearly identical to what their milo averaged during that time. Along with providing a nice income boost in the good year, corn adds diversity to the system and allows Joe to spread his workload and risk.

"My chemical costs really aren't much higher per acre than when I was doing tillage."

Expanded Rotations

Joe sees the potential benefit of even greater diversity than his current rotations possess, and has looked at a number of cover crops over the years. For several years, Joe was doing considerable acreages of Austrian winter peas planted into wheat stubble that wasn't double-cropped, but continual frustration with the inability of the peas to consistently overwinter and grow vigorously in the spring, together with high seed costs, led to the abandoning of the practice. Perhaps finding hardier pea varieties would solve the problem.

In the summer of '01, Joe agreed to work with his consultant, Matt Hagny, to put out a replicated trial to compare several cover crop species with some of the more traditional cash or forage double-crops. The plot included several strips each of sunflower, pearl millet, canola, hairy vetch, sunn hemp, cowpeas, and soybeans, as well as check strips every 20 feet where the planter was engaging the soil but no seeds were planted. All of the crops were planted in 30-in. rows on the 10th of July in a field where wheat had been harvested. The plot area will go to corn in '02, with varying N rates on the strips to assess each cover crop's effect on fertilizer needs of the corn (e.g., the 3 strips that were sunn hemp may get 30, 80, and 130 units of N for the corn, etc.). The plots were hand-weeded in late summer to limit the effects of varying weed seed production (in a field-size situation, one would have more opportunity to manage to prevent weed seed production), and considerable differences in weed pressure were noted between different crops: the check strips and the vetch were the weediest, while the sunn hemp and cowpeas were virtually weed-free.

Photo by Matt Hagny.

2001 cover crop plot at the Joe Swanson farm. In the foreground are two strips of Group 4 soybeans, then three strips of cowpeas (already mature and dried up), and sunn hemp in the background. The cowpeas grew at least twice as fast as the soybeans in the summer heat.

Photo by Doug Palen.

Sunn hemp can produce lots of biomass and fix a great deal of N in a short time. Desirable attributes make it one of the preferred cover crops in Paraguay and parts of Brazil where it is grown prior to wheat seeding, according to Rolf Derpsch at the '02 Winter Conference.

Swanson is looking to gain several benefits from his cover crops and especially likes the legumes as a source of nitrogen (USDA research shows sunn hemp can add 100 lbs. or more of nitrogen to the soil after 8 to 12 weeks of growth), but sees other advantages as well. A big one he noticed this past year was not only were no weeds growing in the sunn hemp, but it was almost devoid of insects. Joe notes that the sunn hemp would have saved two summer burndown treatments last year. While the plot of sunn hemp in '01 was planted in 30-inch rows at three

pounds per acre, he plans to drill his next sunn hemp planting in 15-inch rows at 5 lbs/a. Sunn hemp seed was available for $1.75 per pound in '01, although cheaper supplies might be obtained if larger quantities are imported (a list of cover crop seed suppliers will be posted on www.notill.org in coming months).

In the past, Joe has had an extensive double-crop program and is looking to replace many of those double-crops with cover crops. When asked the reason for the switch, "Double-crops are really risky. We're low on moisture to begin with, and double-crops are many times break-even at best. If I can put in a cover crop for $10 per acre and eliminate two sprayings throughout the summer and add maybe 50 pounds of nitrogen to the soil with a legume, I'm money ahead!"

Joe is also looking at cover crops as a fit between stacked wheat. In 2001, he planted cowpeas (30-in. rows) into first-year wheat stubble. The cowpeas grew vigorously for sixty days, and were then killed with 24 oz of Roundup and 16 oz of 2,4-D and planted to 2d-year wheat. Joe has a check strip in the field with no cowpeas, so we'll see what effect the cowpeas have on the wheat. Sunn hemp might also fit this niche between stacked wheat crops.

"I'm excited about the possibilities with cover crops," although Joe realizes there is much more to learn about them and their effects on subsequent and neighboring cash crops. Will there be an allelopathic effect? Will the cover crop attract or repel insects, and which insects? What will the improved soil tilth be from increased root growth? What will they do to disease cycles? Will they increase the earthworm population? With the proper choice of cover crop and management, "I certainly believe that the positives can outweigh the negatives."

Technology's Role

Herbicide selection is another facet of crop production where Swanson believes in diversity. "I don't use glyphosate on [RR] corn because I'm using it on burndowns and on [RR] soybeans. If I stack soybeans in my rotation, I use Roundup Ready only one of the two years." Joe does all of his own spraying and utilizes a GPS guidance system with a light bar to replace his old foam marking system. "I spray when the wind is down. With the guidance system, I can spray early morning before sunup or at dusk if I have to." Joe notes that diligence in weed control is crucial, especially when beginning a no-till system. "You really have to concentrate on cleaning up weeds —you have to know where your problems are! Depleting the weed seed bank will take extra management and money at first but will pay dividends down the road. My first few years [three] of no-till, my

Photo by Roger Long.

Sunn hemp seeds. A list of seed suppliers will be posted at www.notill.org.

chemical costs went up, but they are much lower now, and really aren't much higher per acre than when I was doing tillage."

Concerning fertility, Joe has tried nearly every method and timing known to man but has settled on applying all fertilizer either at planting or in-season—no preplant applications. Corn and milo receive an in-furrow application (4 to 5 gal. of starter blend) along with 3x0 placement of 50 units of N as either 28-0-0 or 32-0-0. The balance comes in a side-dress application. Some of Joe's low-pH soils (4.8 - 5.3) have been amended with liquid lime applications. Joe notes that he hasn't seen big advantages to liming so far, but wants to take corrective measures before the low-pH does become a major problem.

Joe brings out the fact that many of these 'new' practices that we're finding so useful today really are rooted in history. On his lawn, Joe has an ancient single-disc grain drill, which was horse-drawn and resembles an oversize garden tool by today's standards. He remembers his dad and uncle describing having used that drill to direct-seed winter barley or wheat into standing corn stalks as a common practice. "They really never did all that much tillage even when they got the higher horsepower tractors in the '40s and '50s." Joe says they also had good crop diversity back then: their rotations commonly included alfalfa, kafir, oats, and sweetclover until the 1960s. Joe's dad taught him that "rotations are just terribly important."

Joe, again, "My dad really taught me to respect the soil. If he were alive today, he would really get a kick out of this whole no-till system." This perspective lives on in Joe to this day. While Joe carefully manages his finances, and bluntly states the only reason anyone should be farming is to generate profit, he takes a long-term view: "My goal is to get my soil erosion down to zero and then over the long term actually *build* soil." Carry on, Joe.

Editors' Note: cover crop seed and inoculant donated by: Lipha-Tech, Phillips Seed, Pinnacle Crop Tech., Doug Palen, and Enos Grauerholz

Photo by Sue Swanson.

Joe's dad's no-till drill. The drill's design reveals the ancestry of many features on our 'modern' seeding equipment.

Missed the 2002 Winter Conference?

Get the audio tapes of the sessions from ACTS, phone 314-487-0135, or see the link to ACTS from the No-Till on the Plains website: www.notill.org . Speakers' notes and other highlights of the '02 Conf. are also available on this site.

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P.O. Box 236
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