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No·till On The Plains

Charting a Course

by Roger Long

You know you are talking to a no-tiller when the first thing they talk about is their residue—Kevin Wiltse takes pride in his residue. As with any farmer, he discusses yields as well, but Wiltse understands the importance of residue in getting him to where he needs to go. Yields and profits are the final indicators of whether he has been going in the right direction. Looking at his milo ready to be harvested and wheat just coming up, it is evident that Kevin has been charting a course toward a prosperous future.

Photo by Roger Long.

Wiltse's second-year wheat. Kevin says that 'stacking' really made their no-till hum, by quickly building residue levels and making it tough on weeds.

A no-till wheat field of Wiltse's that was planted the same day as the neighboring conventionally tilled field provides a striking contrast. Even with the visual obstruction of the previous year's wheat stubble, there is much more green than on 'the other side of the fence' where tillage prompted a crusting problem when the area's drought finally came to an end with a heavy rain. As he checks up on his work, Kevin looks at wheat planted into soybean stubble, with great ground cover provided by residue from previous 'stacked' milo crops. On to another field and a milo crop that boasts heads to support 80-plus bushels per acre, in a year where they started with just 18 inches of subsoil moisture and had less than 7 inches of rainfall from planting to maturity. Everything together gives ample proof of Wiltse's navigational skills.

Kevin and his father, Ken, farm approximately 4,000 dryland acres northwest of Great Bend, Kansas. Ken has farmed for over 30 years, and when you talk to Kevin it's evident that he wants to afford the same opportunity to himself and his family. In order to have the chance, the profitability must be there—which means a solid system must be assembled.

It was the obvious robustness of other long-running no-till systems that catapulted the Wiltses into full-fledged no-till. "We went on the South Dakota No-Till Tour in '97—we ordered our drills [a pair of John Deere 1560 no-till drills] as soon as we got back!" They had been dabbling in minimum-till and no-till planting for several years but were

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still using v-blades in their fallow periods. "Just seeing the rotations and how it all worked together is what sold us. We knew we weren't going to get where we wanted to go without no-till. [At Dakota Lakes Research Farm] I remember we walked out under a pivot right after it had just put on 2 inches and we didn't even get our feet muddy." Mud was not a problem this year for the Wiltses, but in just five years, they already have very respectable residue levels.

> **"We knew we weren't going to get where we wanted to go without no-till."**

Their rotation, which relies heavily upon stacking of crops, is ideally suited to provide the mat of residue the Wiltses are looking for. Kevin's baseline rotation is wheat >>wheat >>milo >>milo >>soybeans but he uses several variations on it depending upon current conditions. Kevin has substituted corn for the first milo but notes that the drought of the past couple of years has decimated the corn yields. Corn may take a short hiatus from the rotation due to the economic impact of dismal yields, but might find its way back eventually. Kevin sees the value corn has on the system: "Corn gives you a chance to use herbicides with different modes of action and it finishes earlier which many times translates into more moisture for the following crop." Sunflowers have sometimes taken the place of soybeans, but Kevin doesn't like the high input costs for insecticides and fertilizers needed for flowers, and notes that weed control is not as good in the flowers, which creates weed problems for years to come. He also notes that soybean stubble is a better seedbed for wheat than sunflower stalks.

An Ounce of Prevention

Each crop, each *step*, within the rotational system offers unique opportunities that must be capitalized upon in order to keep the system profitable. For instance: "The second milo crop is really cheap as far as herbicides go because we don't have to keep spraying wheat stubble." Another example: Kevin notes the difficulties he was experiencing with nutsedge, which had built up a major presence long before they went to no-till. He was having trouble keeping this perennial weed in check, only having partial success with 0.5 oz of Classic in his soybeans, and sometimes getting some good out of Spartan put down ahead of the sunflowers. However, his burndown success ahead of milo was often quite poor, and was plenty erratic for sunflowers too. After discussing the problem with agronomist Matt Hagny, Kevin started using higher rates of glyphosate for burndowns and delaying those applications when possible, as well as focusing on cleaning up the problem in the soybean and wheat years instead of the milo years. Kevin explains, "I usually wait till [the nutsedge] is 3 inches or bigger

Photo by Roger Long.

Wheat in soybean stubble—note the abundance of milo stalks remaining from 2 and 3 years ago.

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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.

to spray or there isn't enough foliage there to take the chemical down to the perennial root." Kevin notes that the herbicide itself is not enough, "You've got to have competition [shade] out there through the summer to really make it work." An additional benefit of keeping the nutsedge under control is that nutsedge is a host for billbugs, which can devastate milo. By attacking the problem in the most opportune window, Wiltse's nutsedge is kept in check and the entire system runs more smoothly.

Nutsedge & cupgrass control isn't herbicides alone: "You've got to have competition out there through the summer to really make it work."

Prairie cupgrass is another potential glitch. Wiltses use 32 oz of glyphosate and make sure to spray before the grass gets over 2 inches in height. They have also had good success with cutting the rate of glyphosate to 20 oz and tank-mixing Assure at 8 oz per acre, which gives them an additional mode of action. Again, if cupgrass has to set in the shade of a summer crop (as opposed to a fallow period) the weed really struggles to compete. Kevin is using the system to fight *numerous* problems!

After talking to Kevin for a while, the timeliness with which this no-tiller operates smacks you in the face. Their weed control is highly dependent upon timely, well-placed herbicide applications. Along with their new drill purchase in '97 they also bought a self-propelled Patriot sprayer. The Wiltses see smart, timely chemical applications as such an important facet of their operation that they have set up a separate corporation for the business of spraying. Kevin bills himself and his dad for chemicals as well as a custom application charge. The application income then goes into an account that is used for equipment replacement (they have already replaced that first sprayer with a 3185 Case-IH purchased in '01). Kevin also does some custom application for neighbors with the sprayer and keeps his custom applicator's license up-to-date as well as all the record keeping.

Kevin has put all those years of relying upon himself for profitable spray applications to great use. "I really don't have herbicide failures. If you're not applying in 95-plus-degree temperatures and you're getting good coverage—the chemicals are going to work!" Want a few good spray 'tips' from Kevin? Better install XRs. "My XR tips give me my best performance in weed control. The air-induction [AI] nozzles do reduce drift but the coverage isn't as good. If I'm spraying next to a sensitive crop, I'll flip down the AI tips and spray a couple of rounds and then switch back to the XRs." And with the help of his onboard Raven global positioning system, finding the old foam marks is not an issue. When asked if he sprays at night: "I've done it, but it's a little scary. When you can't see the end of your booms and you're crossing terraces, it's a real uneasy feeling!"

Photo by Roger Long.

Kevin Wiltse filling their pair of 1560 drills.

Timing!

Wiltses have had great success in converting CRP acres back into grain production—without tillage. They have taken out over 700 acres in the last several years and love the planting conditions provided by the rich entanglement of old grass roots. Kevin is a little confused as to why anyone would want to use tillage to take out CRP. "It's our most forgiving soil. And it's just due

"I'm pretty fortunate . . . during the summer, when everyone else around is out working ground, I get to spend a lot of time with my two kids."

Photo by Roger Long.

Wiltse had decent milo despite a severe drought in '02, thanks to no-till.

to the structure and root mass that is still there." To start the process of killing the huge biomass accumulated by 10-plus years of perennial grass growth, they begin about 10 months before the planted crop. "We try to get in around July, after a rain, and hit it with 64 oz of Roundup—yeah, that's a little expensive but it's still cheaper than working it 3—4—5 times and then they [the conventional tillers] still have boulders out there to deal with." The Wiltses make only the one application in the summer and then the following spring they plant soybeans. They then treat those soybeans like any other Roundup Ready soybean field. "We may have a little trouble with some switchgrass but everything else is pretty well cleaned up and even the switchgrass fades pretty quickly." Kevin has tried wheat as the first crop into CRP but likes soybeans much better. "When we planted wheat, we put on 120 lbs of N and the wheat was still yellow—there's just too much biomass out there to get on enough nitrogen."[1]

When we drive up to another field, we catch Ken refilling the drills as he finishes planting wheat into an old alfalfa stand. The disturbance from the drills is minimal—an important detail for an area where winter wind erosion can be serious. Their drills have been fitted with tanks for putting on an in-furrow liquid fertilizer starter. For wheat, they put down 20 lbs of N and 20 lbs of phosphorus. Once the wheat is up, Kevin puts the sprayer back to work by applying another 80 lbs of N in a top-dress application. "In years when we don't need a herbicide, I take the spray tips out and we just stream on the N." Kevin hasn't seen much yield difference between sprayed or streamed N, but notes that the streamed N can go on in slightly higher winds and that there should be less 'tie-up.'

Photo by Roger Long.

This field was CRP, then no-till soybeans, then wheat, and now wheat again. A clump of long-dead CRP grass is visible yet in the center of the photo.

Wiltses' pair of 1560s (10-inch spacing) plant everything except the corn and sunflowers. Their drilled milo gets a winter (generally January) application of urea and then 5 gallons of 10-34-0 in-furrow at planting. One of Kevin's goals is to eventually have an air seeder and put down dry fertilizer on every other row—"but that may have to wait until we've had a few wetter years." As with many no-tillers, their equipment inventory is low, and yet they do quite a bit of custom seeding and spraying each year. Besides their drills and sprayer, they have a Case-IH 955 planter for the corn and sunflowers, two tractors, and a little hay equipment—that's it! Since they are reducing corn and flowers in their rotations, Kevin wonders whether they even need to have a planter around.

Photo by Roger Long.

Kevin and father Ken finishing up '02 wheat seeding.

For now, Kevin is relatively happy with his yields (all things considered) and his workload. "I'm pretty fortunate . . . during the summer, when everyone else around is out working ground, I get to spend a lot of time with my two kids." After all, shouldn't a manager's quality of life be part of the system?

We walk out on one of Wiltse's wheat fields that was CRP in 2000. This year's stand of stacked wheat looks quite 'at home' among the stubble rows from last year. As I marvel at the beautiful stand, Kevin points out the still discernible crowns from the Indiangrass and the big bluestem that dotted the field just three years ago. Just one more compass reading to check as he again asks himself whether his system is taking him where he needs to go. A modern Marco Polo, Wiltse has the right combination of confidence, skepticism, and intellect to find his way on this no-till frontier.

[1] The perennial grass residue has a large carbon-to-nitrogen ratio. For the microbes to break down the residue, they need additional nitrogen and will speedily 'soak up' the fertilizer N so that it is no longer available to the growing wheat crop. The net effect is the wheat doesn't get enough nitrogen because it's being used by the decaying CRP, even if all that N will become available sometime later. Low phosphorus is often an additional problem in this situation, as the perennial plants have done an excellent job of gathering up all the available P from the soil, and very little is available until some of this material decomposes.

Leveraging Biology

by Matt Hagny

SCIENCE

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

In the Big Picture perspective, all we're trying to do out in those fields of crops is to 'leverage' the biology to our benefit—to extract a little more than we put in (hopefully a whole lot more, but this is often not the case unfortunately). After all, the crops we grow are merely slightly altered forms of wild plants—selected over the millennia to be more 'user-friendly' than their wild cousins, often with traits such as larger seeds for easier harvesting or processing, less dormancy, more responsiveness to fertilizers, etc. But in the search for greater efficiencies, crop genetics are only one piece of the puzzle.

Think of your fields as ecosystems—you can't sterilize the whole thing and have only the crop out there. Nature isn't easily confined or excluded. Life is quite resilient—the biology just can't be kept out without extreme measures. Think about your shower curtain or bathroom tile—no matter what you scrub it with, the mildew and other living 'gunk' show up again in a few weeks. Or how about hospitals—supposedly nice and sterile, right? Not so—a high percentage of nasty infections and diseases are transmitted during hospital stays and medical procedures, despite the advances of modern medicine. So a person can hardly expect to have complete control over big fields of crops, in the great outdoors—at least not without massive technology, deployed at a staggering cost.

We need to look for ways to manipulate the system to get what we want—to find those places where we can exert small pressures and produce big changes, to leverage biology in our favor.

Instead of focusing on wiping out the population of pesky organisms, we should instead be looking to avoid the confrontation, or at getting the suppression some other way. 'Brute force' technology generally fails to subdue biology—the technology is very costly, plus, the target often evades the control measure (particularly if used repeatedly), and the side-effects are sometimes unanticipated and unpleasant. So we need to look for ways to manipulate the system to get what we want—to find those places where we can exert small pressures and produce big changes, to leverage biology in our favor. Give me a lever and a place to stand, and I will move the world. Or at least nudge it. Really, what we want to do is mostly observing, with very little intervening—a good system will run fine by itself much of the time.

Hired Guns

While some 'rules' undergird the whole shebang, most of the practical pieces must be learned in dribs and drabs—the effects are often rather specific to a location and the circumstances involved, and not all that predictable (at least with our current knowledge). What *is* predictable: for much of what you could want done, biology provides a way, although sometimes the pace is too slow for us.

One of the most visible ways of leveraging biology is using beneficial organisms to control harmful ones—essentially nurture your allies and let them fight your wars for you. We've heard about the importance of "beneficials" for years, and how some farmers purchase and release beneficials in their fields to boost numbers—i.e., biocontrol. The problem was in having to purchase and release them. Why not ensure that their numbers were high from the start? This is what can occur in a well-managed no-till system. Keeping crop residues on the surface holds moisture and creates an

Photo by Matt Hagny.

Technology is nice, but growing healthy crops is often accomplished more profitably with diverse rotations, no-till, and good agronomy.

environment suitable for these beneficial organisms, ensuring their population builds early and stays strong. Lady beetles and lacewings are often given most of the credit, but spiders actually do much of the work when it comes to controlling damaging insects. In cotton, for example, spiders are very important for controlling fleahoppers (*Pseudatomoscelis seriatus*). For years, I had noticed fleahoppers damaging some early squares (buds) in our no-till cotton fields, but often the levels never became all that serious, even if no control measures were taken. I always wondered what was doing the control for us, until I realized much of it came from spiders capturing the fleahopper nymphs (there may be other control mechanisms also—the point is that fleahoppers rarely reach damaging levels in well-managed no-till cotton).

Photo by Matt Hagny.

Double-crop cotton? No—actually the cotton was seeded into a cover crop of wheat, which was killed while the cotton was seedling. The evidence is convincing: cover crops ahead of cotton build populations of spiders and lady beetles, which works wonders for controlling the thrips, fleahoppers, aphids, and bollworms that show up later in the cotton. Biocontrol for free!

Establishing a good beneficial population early involves providing habitat and a food source for them, by keeping residue on the surface (or, better yet, a growing crop) and not spraying insecticides. Spiders and lady beetles will feed on a wide range of other organisms, and can establish populations long before damaging insects ever show up—but these beneficials can't prosper in the barren wasteland of a tilled field. However, a winter cover crop killed just before cotton emergence (or even early post-emerge)[1] really builds the spider and lady beetle population early, which will typically control thrips, aphids, and bollworms (having some milo and corn in the vicinity really helps, too, as the bollworm [a.k.a. earworm] moths prefer to lay eggs in those crops). Consequently, in well-managed no-till cotton in Kansas we have virtually eliminated post-emerge insecticide use—*without Bt* varieties.

Similar measures keep European and southwestern corn borers at bay—a good supply of lady beetles will devour most of the eggs and larvae, although it is strictly a 'numbers game.' Some areas of the northern U.S. Plains tend to have consistently higher numbers of corn borer, prompting the question of which biological suppression mechanisms might be available. Of course there's *Bt*, a human-engineered utilization of biology.[2] But we'd like something on a more affordable and renewable level. Dwayne Beck has speculated that bats (the flying mammals, not the baseball stick) may well do the trick, consuming a number of

Photos by Matt Hagny.

Let sleeping dogs lie! Don't plant the weed seeds—they won't bother you until you push them into the soil. Leave them on the soil surface, to be consumed by insects, to rot, or be weathered away. Here, trying to do just a little too much with the planter's residue managers resulted in a massive waterhemp flush emerging—thick enough to prevent good herbicide coverage (poor kill in left photo) and to seriously affect corn yield. Notice that over 99% are in the row—almost zero between the rows—mostly due to the row cleaner's disturbance.

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1 The cover crop often adds yield, too—many times the best cotton comes from fields where wheat cover is killed about the time of cotton planting.

2 In the wild, the bacterium *Bacillus thuringiensis* produces substances toxic to Lepidopteran (moth and butterfly) larvae, such as corn borer. Researchers successfully moved the genetic snippet for producing this protein into several corn genomes, causing the resulting "Bt" corn plants to produce those toxins in some of their tissues. In the wild, such shuffling of genetic material between species is known to occur when mediated by viruses—genetic 'engineering' is an ancient occurrence.

corn borer moths each night before the moths lay their eggs. So perhaps we should be building bat habitat in our fields.

Other insect problems can also be avoided with good management. Corn rootworm can be handled by rotation, so long as the rotation isn't too short or predictable (see issue #1 on stacking)—this is basically deprivation of a host. Chinchbugs in milo aren't as bad in no-till, although I'm not sure why (I've been told it is due to a fungus). Greenbugs and other aphids in corn and milo are generally reduced in no-till, as has been documented by some researchers.

Sure, we haven't got all the pests under control yet, and sometimes we get 'ambushed' by something (such as snails in South Australia). We still fight grasshoppers—we haven't found much for ways to marshal their natural enemies against them yet, although they don't seem any worse in no-till than anywhere else (in fact, just the opposite seems to occur—the grasshopper populations seem to move in from the grasslands and brome waterways). Sunflower headmoth defies biocontrol, at least thus far. Often it is simply insufficient knowledge.

Beyond competition for resources, plants may even *actively* suppress each other with 'chemical warfare'—emitting compounds to limit the growth or even kill neighboring plants. The first herbicides were used by *nature*!

A Jungle Out There

What about weeds? They do seem to 'disappear' when left on the soil surface, which is well documented (see Randy Anderson's data in issue #1, or Leon Wrage, an SDSU weed specialist). Some of this is biology (predation), and some is just pure weathering and chemical degradation. Leaving the weed seeds on the soil surface maximizes these mechanisms. Temperature fluctuations and sunlight are strongest on the surface, as well as the most feeding by ants, beetles, crickets, etc. And the same microbial and fungal feeding that degrades stubble also works to destroy weed seeds. The greatest amount of biology is almost always in the duff layer on the surface and the half-inch of soil underneath, which is also true of nearly all other ecosystems on land—the interface of a substrate, minerals, gases, and sunlight. Generally, most of these decay processes are accelerated under crop canopy conditions (by keeping the humidity higher). These processes seem to go along just fine by themselves, especially after a few years of no-till (indeed, sometimes our crop residues decay a little more quickly than we'd like). Weed seeds are further disadvantaged by just lying loosely on top—a poor place to germinate, except in very damp environments.

Photo by Matt Hagny.

Crop competition is a major part of weed control: here, a drill skip allowed the weeds to go berzerk, while the areas with thick wheat were almost perfectly clean. Make the most of crop competition by doing what it takes to achieve thick healthy stands, which is exactly what needs to be done anyway.

Another component of biological control of weeds is competition from your crop. Sunlight and nutrients are limited in supply, not to mention pure physical space to grow. What is it you don't like about weeds? Obviously, they take something away from your crop's growth and yield. Turning this around helps level the playing field—so make the crop as competitive as possible. Proper seed and fertilizer placement help 'build' a vigorous crop, as does selecting quality seed (usually larger seeds with high germination) with genetics to grow quickly. Thicker stands and narrower rows will help, too. Anderson showed that using a tall variety in narrower rows with N placement reduced weed seed production by 40 to 45% in wheat. Of course, rotations are key to effective biological control, as crops will be competitive at different times of the year.

Windmillgrass & cupgrass do not 'blow up' or become prevalent in other systems—those species exploit an opportunity created by ecofallow. Remove the opportunity, and they fade quickly.

Beyond competition for resources, weeds may even *actively* suppress crop growth with 'chemical warfare'—emitting compounds to limit the growth or even kill neighboring plants (the first herbicides were used by Nature!). Sometimes this works the other way as well, and a crop will do a decent job of actively suppressing one or more weed species. This chemical warfare, or allelopathy, is only beginning to be understood yet is another biological tool to be used to our advantage, if only we would.

One striking example of the failure to make use of competition is the "ecofallow" program in western Kansas, which is basically a wheat >>milo (or corn) >>summerfallow rotation. After a few cycles, windmillgrass (*Chloris verticillata*), prairie cupgrass (*Eriochloa contracta*), and other "go-back" grasses dominate the system, resulting in the desire to 'solve' the problem with tillage—using v-blades, undercutters, plains plows, or whatever you want to call them. The interesting thing is that these grasses do not 'blow up' or become prevalent in other systems—only in that rotation. These grasses share a few tough management characteristics, such as tolerance to low rates of glyphosate, but also are weak in that they don't produce much seed and are not terribly aggressive in their growth habits. Why did they come to dominate? The system gave them an opportunity. The herbicides used (low rates of glyphosate + growth regulators in the wheat stubble and again in the summerfallow, atrazine + acetamides in the milo) were not particularly good on the windmillgrass, etc., and in fact helped them by removing competition from other weed species susceptible to those herbicides (pigweeds, kochia, foxtails). Of course, the crop competition was zero in the summerfallow year, only moderate in the wheat year (with a long summer for the windmillgrass to recover), and not overly wonderful in the wide-row (30 to 40-inch) milo either. Soon, the thing fell apart—Nature had found the Achilles' heel of this cropping system.[3]

The game gets more complicated when we realize that disease-causing species have characteristics that may shift in response to their environment—the control measures used, including adapting to rotations.

While many now consider the v-blade an integral part of their management of that system, it need not be so. Many producers have cleaned up problem fields of those grasses with good rotations and proper herbicide selection, relying on more 'fop' and 'dim' herbicides and higher rates of glyphosate. But the death-knell to those weeds is a dense canopy above them during the summer—they cannot tolerate being shaded. Putting a vigorous broadleaf summer crop into the rotation fixes the problem with biology, and has many other desirable attributes as well. I have clients who have nearly eliminated windmillgrass and cupgrass in some fields by using narrow-row soybeans and well-chosen herbicides, without any mechanical tillage devices whatsoever. Despite a constant supply of windmillgrass blowing in from borders and adjacent pastures, we see no windmillgrass problems developing. Summer broadleaf crops other than soybeans appear to address the problem similarly, in varying degrees, depending on their canopy and growth characteristics.

Rotations, competition, and weed seed disappearance have dramatic impacts on weed populations in no-till fields. However, herbicides still pick up the slack, partly because we do not sufficiently exploit these other control measures, and partly because we have bred crops to have fewer defensive traits while going for bigger yield potential. The most economical system will make judicious use of all these means.

Choices of crop sequencing are really one of the ultimate tools available for leveraging biology in the producer's favor. The consequences of getting it right are big.

Photo by Matt Hagny.

Competition works both ways—here, a spray skip let prairie cupgrass get the upper hand on the cotton before the skip was remedied. The cotton in the skip never recovered.

Unhealthy Living

What about crop diseases? Diseases aren't quite as obvious as insects and weeds, and may not receive as much attention. But they're still in the realm of biology, and of biological controls.

[3] The ecofallow program also caused shifts in annual grass biotypes and species toward those more tolerant of acetamides, since this was almost the only major pressure being applied to some of the summer grasses. In some regions, nutsedge also became predominant under ecofallow or similar systems that provided the opportunity. As Beck observes, "Mother Nature is an *opportunist*—she's not a bitch."

Photo by Matt Hagny.

The strip in the middle of the photo had sunn hemp planted after wheat harvest, while the strips on either side did not. By the following spring, it was obvious that the sunn hemp had vastly reduced the nutsedge pressure, which is the green visible to the left and right of the sunn hemp strip.

Disease-causing organisms all have resting (dormant) stages, called spores, conidia, apothecia, perithecia, sclerotia, etc. depending on the structure produced. These can survive for some time until coming into contact with a new host. Interfering with disease infection and/or progression in plants can involve several mechanisms, such as reducing the levels of these resting stages in the environment (soil or air), disrupting their 'sensing' of the proper host, or enhancing the plant's defense mechanisms.

The secret is in figuring out how to let nature solve your problems for you.

Reducing inoculum load may involve longer intervals of non-host plants, or other ways of increasing attrition of the resting structures—time, chemical weathering, and biological predation are your allies. Having a crop growing in the field often creates conditions that either accelerate the death of these enemies, or that actually fake them out of dormancy (only to find themselves trying to infect a non-host species, or one that isn't the cash crop).

This is perfectly illustrated by a recent study of white mold (*Sclerotinia sclerotiorum*) levels in soybeans as affected by cover crops, conducted by Craig Grau of Univ. Wisconsin. White mold is a scourge of the Northern Plains, especially in areas with 'tight' rotations of susceptible or carrier plants, such as soybeans, canola, and sunflowers. It is worst in humid conditions, and during the late '90s caused much of the Corn Belt to revert to wide-row soybeans and other yield-limiting management strategies, such as planting semi-resistant varieties—all in an attempt to avoid disastrous levels of white mold. Looking for a better way, Grau suspected a biological solution might work. In a no-till corn >>soybean rotation, Grau compared cover crops of winter wheat, spring oats, and spring barley (all non-hosts) grown ahead of soybeans, versus check strips of no cover crop. Over multiple years and locations, Grau found that white mold incidence in the soybeans was significantly reduced by all three cover crops, and that the white mold resting structures had indeed broken dormancy in all of the cover crop strips, but not in the check strips.[4,5]

The game gets more complicated when we realize that disease-causing species have characteristics that may shift in response to their environment. Just like some human pathogens have evolved resistance to all known anti-microbials, so does the population of any given crop pest adapt to the control measures used, including adapting to rotations. For instance, *Bipolaris sorokiniana* is a soil-borne fungus causing common root rot in both wheat and barley. Five years of monoculture wheat will cause the population of *B. sorokiniana* to change from being weakly virulent to wheat to becoming highly virulent to wheat, as demonstrated by R.L. Conners and T.G. Atkinson.[6] The opposite occurred with five years of continuous barley: the *B. sorokiniana* increased in virulence

Photo by Matt Hagny.

Dakota Lakes Research Farm studies crop rotations in both dryland and irrigated no-till regimes, to discern which sequences and intervals can be exploited to maximize productivity.

[4] Long-term use of cover crops to prematurely break the dormancy of white mold sclerotia may result in shifts of that species toward more precise germination requirements, i.e., *Sclerotinia sclerotiorum* might begin to break dormancy only when sensing compounds exuded by soybean roots, but not winter small grains. Cover crops may be highly effective in the short-term however, and would maintain some effectiveness regardless, to the extent that predation and decomposition would be higher under a canopy of cover crop. A number of fungi are known to attack or inhibit *S. sclerotiorum* in the soil, including *Coniothyrium minitans* (which is actually marketed as a biocontrol product), *Sporidesmium sclerotivorum*, *Trichoderma spp.*, and several others.

[5] Yields of soybean were highest following the cover crop winter wheat. Whether winter wheat is the ideal cover crop ahead of soybeans remains open to debate—observations in S. Dakota and Kansas indicate allelopathic effects on the soybeans, which do not seem to occur when winter rye or oats are used instead of wheat. In Grau's conditions (high moisture, high disease), the additional growth of the fall-seeded winter wheat (compared with spring-seeded oats or barley) likely overwhelmed all other factors.

[6] R.L. Conners & T.G. Atkinson, 1989, Influence of continuous cropping on severity of common root rot in wheat and barley, *Can. J. of Plant Pathology* 11: 127-132.

to barley but decreased in its ability to colonize wheat. Other studies support the findings of short rotations (or monocultures) causing increases in both inoculum levels and disease aggressiveness for most pathogens.[7] Planting non-host crops reduces inoculum levels, but may not alter that pathogen's adaptedness to the host crop, whereas planting crops that are weak hosts or alternate hosts may increase inoculum by allowing the pathogen to reproduce, but may actually reduce the pathogen's aggressiveness in relation to the primary host crop.

Underground World

The roots of your crops grow in a unique world—an ecosystem largely unseen and unexplored by humans. Which vascular plants (crops and weeds) are allowed to grow in your fields will radically alter that ecosystem every year.[8] Every plant has a 'signature' of root exudates (substances leaking from roots), and these exudates may attract or discourage certain species among the diversity of bacteria, fungi, nematodes, and other organisms in the soil. Those species often vie for root exudates as food sources, to the extent of bacteria that produce antibiotics (to kill the competition) and plant growth stimulants to increase root growth.[9] In turn, some of those species will be food for still other species. Other organisms are free-living, adding to the richness of the soil ecosystem. Many of the species found in the soil ecology help the vascular plants, directly or indirectly—by creating or liberating nutrients, discouraging harmful organisms, or just by occupying a niche (a robust ecosystem has great diversity, which discourages both invasion and erratic population swings by the various species).


Photo by Matt Hagny.

Many of those organisms in the soil are your friends, as Dwayne Beck explains while examining a soybean root.

Soil ecosystems are slow to reveal their secrets. Many of the "rotational effects" we observe are likely caused by shifts in the soil community, as they are not explainable by moisture levels, nutrient cycling, or known diseases—a conclusion reached by many independent researchers worldwide.

Choices of crop sequencing are really one of the ultimate tools available for leveraging biology in the producer's favor. The consequences of getting it right are big. For instance, in '02 at Dakota Lakes Research Farm in the w.wht >>corn >>broadleaf rotation, *winter wheat yields varied from 8 bu/a to 56 bu/a depending on the preceding b-leaf crop.* It was a dry year (understatement), so the wheat after soybeans making only 8 bu/a isn't so surprising. The shocker is the wheat making 56 bu/a after field peas, but only 28 bu/a after canola and 28 after chickpea. According to Beck, wheat after field peas is always some of the best. Moisture, organic N, and mycorrhizal levels may explain some of the differences, but mostly we just don't know why.


Photo by Keith Thompson.

The living fraction of the soil can profoundly alter its properties over time.

In another example, Randy Anderson's long-term work at Akron, CO shows an increase in wheat yields of 46% by having corn in the rotation (w.wht >>corn >>fallow versus w.wht >>proso >>fallow). On the other hand, including sunflower in the rotation *decreased* wheat yields significantly, even with a year of fallow after the flowers, although the loss was reduced (but not eliminated) if a year of corn was included ahead of the flowers.

Underworld inhabitants also have many desirable effects on soil physical characteristics. Want to loosen and aerate the soil? Earthworms can handle that for you, as can plant roots. Redistribute nutrients? Earthworms again. Help plant roots absorb nutrients and water? Mycorrhizal fungi to the rescue. And all of these helpers work best in continuous no-till.

[7] Some exceptions occur, such as is commonly reported with take-all in wheat—these soil ecologies are termed "suppressive," and are thought to be caused by a resurgence of the 'enemies' or antagonists of the pathogen in question. There is some debate as to whether this is dependent on one or two species, or on entire ecological shifts. In any event, suppressive soil ecologies deriving from monocultures tend to only be effective at controlling a few pests, and do not develop equally in all soils and climates.

[8] Not only which crop is grown, but which *variety*, significantly affects the soil ecosystem.

[9] Jill Clapperton, *Creating Healthy Productive Soils*, from Alberta Reduced Tillage (ARTI) website.

Building a Better System

All of this is just leveraging biology in our favor (or not). The secret is in figuring out how to let nature solve your problems for you. Fields are ecosystems, and they may either be on life-support or be quite robust. Sometimes we don't even know how close they may be to crumbling. The nature of epidemics is such that we have been notoriously poor at predicting and preventing them.

The take-home message is that, in the biological world, brute force generally fails. The target almost always finds ways around the pressure, i.e., the pressure forces the target population to shift. Even if this weren't the case, the technology is usually expensive. Biological solutions often can be 'persuaded' to work for less cost, and they are 'on the job' when and where they are needed—much more so than applied inputs.

None of this is intended to be an 'avoid technology' message—technology is wonderful, especially when it is used for those problems at which it excels. However, it seems that we have gotten sloppy in thinking technology will bail us out of every jam, or that every new technology must be the most economical way to doing something. The electronic era certainly didn't spell the end of paper (as some predicted)—we use more than ever—nor will slick new technologies allow you to utterly control everything in your fields and forget about the underlying biological and ecological principles. Your fields will always be a messy tangle of wild biology. Embrace it. Learn to exploit it. This time at least, the future belongs to those with a bit more subtle understanding and finesse.

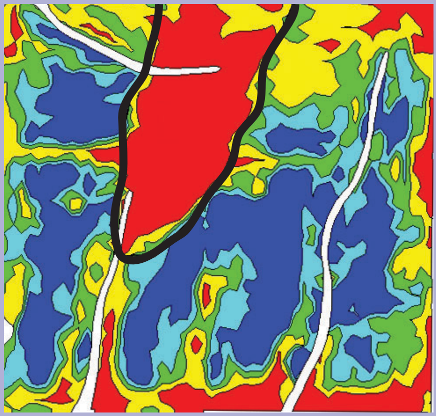
Editors' Note: To learn more on "leveraging biology," catch our blockbuster array of speakers for the No-Till on the Plains' 2003 Winter Conference in Salina, including venerable no-till researchers Dwayne Beck and Rolf Derpsch. Another featured speaker will be Jill Clapperton, soil ecologist at Lethbridge, Alberta, who will heighten our awareness of fundamental biological happenings in the root zone.

Up in Smoke

The first yield map is for a 2001 corn crop (2d-yr corn) in a long-term no-till field in north-central Kansas, and shows an area where a fire during the previous year's harvest caused a little yield loss—33.9 bu/a! The area is outlined. The yield loss was primarily due to lost moisture-holding capability, although increased weed pressure was also noted in the burned area (the method of using fire to destroy weed seeds didn't work very well here—heck, no, it triggered them to germinate).

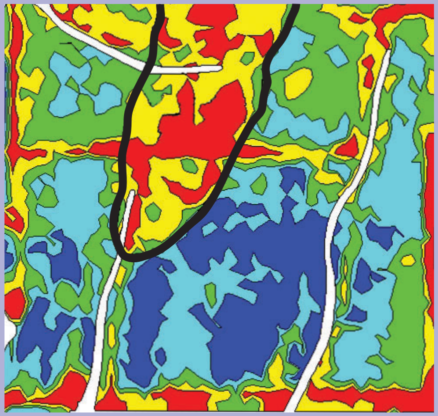
The burned area was still quite evident in the '02 milo crop, depicted by the second yield map. These are but two examples of the value of residue. So keep it under cover—anything else is playing with fire!

2001 Corn



Yield reduction in burned area 33.9 bu/a.

2002 Milo



Yield reduction in burned area 26.9 bu/a.

Calendar

JANUARY

7-8
FACT conference, Liberal, KS

8-11
Lessiter's National No-Till Conference, Indianapolis, IN

27-28
No-Till on the Plains' Winter Conference, Salina, KS

FEBRUARY

4-5
South Dakota No-Till Assoc. Conference, Sioux Falls, SD

4-5
Colorado no-till conference, Greeley, CO

Choose Carefully

This winter, as you book your seed purchases keep in mind the value of diverse genetics. You never know what the upcoming season will hold—whether it will be weird weather, or some insect or disease outbreak. Since you can't predict these things, the best bet is keeping diversity high in the hybrids and varieties you plant.

We all know the examples. The stripe rust outbreak in the '01 Kansas wheat hit '2137' hard, but didn't bother 'Jagger' much at all. Or the tough winters where Jagger just barely survives (or not). Sometimes early heading varieties do better, sometimes not.

The same is true for the summer crops. In 1970, the new race T of southern leaf blight was very damaging to all corn hybrids possessing one specific gene—other hybrids were fine. Things like this happen, and then the plant breeders have to go back to some of the wild varieties or early domesticated lines to try to find a source of native resistance. However, quite often a degree of resistance is in some of the modern lines, but not all. But you won't know what you've got (or what you need) until it's put to the test during the growing season. And no two seasons are ever the same.

Do you need to plant 10 or 15 different hybrids? No, not at all. Just plant 2 or 3 of the best, but make sure they are rather different genetically. How will you know if they're different genetically? Well, if they have different physiological characteristics, they are at least somewhat diverse genetically. For instance, a taller variety must not have exactly the same genetics as a shorter one. Physical traits are numerous, such as grain color, earliness, leaf angle, etc. and may be used to help gauge genetic relatedness.

Sometimes information on the actual crosses or genetic group is available, which makes the task a bit easier. For instance, you may have information that wheat variety *x* was created by the crosses of *a/b/c* while *y* came from *c/d/e*. This helps, but you still don't know how related the lines of *a*, *b*, *d*, and *e* are. Similarly, some companies offer codes or groupings for their seed line-up, perhaps designating a product as from their "Genetic Group Q," or being a "Lancaster type," or whatever. This is commendable, but doesn't completely solve the problem, especially if you want to shop around between companies.

The problem gets worse once you realize that a single hybrid or variety may be available from many different companies—you may be able to get that particular corn or milo hybrid from 15 different companies, and they will all be identical except for seed quality, price, etc. You may be able to get the same soybean variety from two dozen companies. The reason this happens is that many companies get either the breeding material or the finished product (the seed to be marketed) from various 'wholesalers' of ag genetics—Holdens, Stine, Illinois Foundation, Iowa Foundation, Crosbyton, etc. But at the same time, many retailers have their own breeding programs, or (in the case of hybrids) cross the wholesale genetics in unique ways, or make selections from them to 'improve' them slightly.

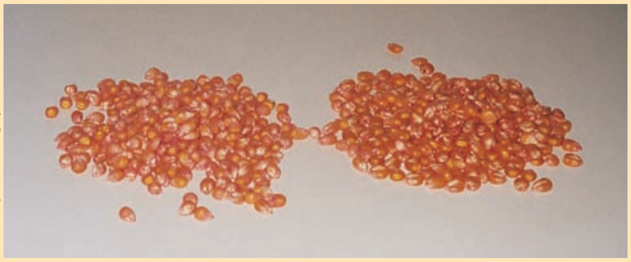


Photo by Matt Hagny.

Diverse seed genetics spreads risk. Are you getting the diversity you need? Seed from two different companies may have identical genetics.

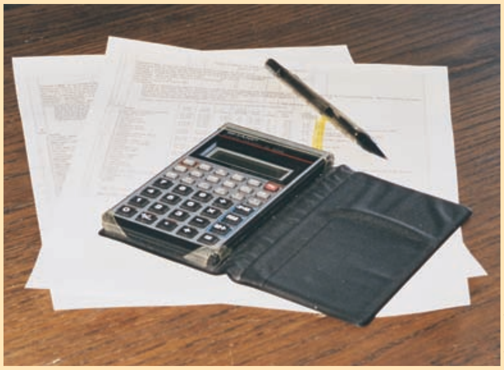


Photo by Matt Hagny.

Making good choices depends on analyzing good data, and lots of it.

By now, you may think these companies have been pulling shenanigans at your expense, and perhaps they have. But it is not so different from any other industry. Indeed, you can often buy exactly the same bearing (that came from the same batch off of one assembly line) from two different places, paying anywhere from 30% to 300% more for the one that comes in the shiny plastic wrapper from the implement company. With seed genetics, it's simply a little harder to discern the differences, at least until you grow them out.

While we're on the subject of selecting varieties, it should be noted that people are often overly confident of their choices. They put in a side-by-side test, or look at a nearby test conducted by the university, and say, "Hybrid *x* was 12 bushels better than *y*—guess I will plant all hybrid *x* next year." How likely is it that the yield difference will be repeatable, i.e., real? Only about 60%. But increase that to 10 tests, still with a 12 bu. measured advantage, and the likelihood of the difference being real edges up to 90%[1] (which is still the wrong choice one year in ten, on average). And many people place great significance on differences of much less than 12 bushels. It's sorta like closing your eyes and reaching into the bottom of your toolbox where all the stray nuts and bolts accumulate, pulling out a ½-inch locknut, and saying, "Aha! This box is *full* of ½-inch locknuts!" Maybe so, maybe not. But repeated sampling improves your picture of what may be in the box, and the same is true of crop genetics—we place way too much emphasis on our own tests, when we could do so much better by sampling over a bigger area and multiple years.

So study up, since performance isn't necessarily "in the bag!"

[1] Assumes 100 bu/a test average with C.V. of 15 or less.

No·till On The Plains

New Coordinator

No-Till on the Plains, Inc. would like to welcome our new staff, Brian and Jana Lindley of Wamego, who have a farming and ranching history in south-central Kansas. Lindleys can be reached at P.O. Box 379, Wamego, KS 66547, or by phone 888-330-5142, or at notillontheplains@wamego.net.

Paradigms and Decision-Making Frameworks*

by Peter Donovan

PERSPECTIVE

Peter Donovan is a reporter and livestock herder in Enterprise, Oregon.

**Editors: What follows is selected from an article at www.managingwholes.com, reprinted with permission.*

When we are dealing with paradigms and beliefs, there is no opportunity to choose without awareness. The following is an attempt at revealing what is usually hidden.

What limits change in human affairs?

Paradigms are habits of thought, unstated rules, assumptions, or beliefs that define the boundaries we operate in. We are not usually directly aware of these habits of thought, nor are most of us taught about them in school or on the job. Yet much of what we 'see' is determined by the reality *behind* our eyes—the 'landscape of the mind.'

Once a boy and his father were driving, and they had a bad accident. The father was killed and his son seriously injured. At the hospital, the surgeon who examined the boy said, "I cannot perform this operation. This boy is my son." How can this be?

Albert Einstein observed that the kind of thinking that got us into the present situation is *not* the kind of thinking that will get us out of it.

Paradigms often limit our perceptions and awareness. We are unable to see something that does not conform to our basic assumptions. (We may assume all surgeons are men.)

As it is said a fish is the last creature to discover the existence of water, we are often the last to see our own habits of thought. Albert Einstein observed that the kind of thinking that got us into the present situation is *not* the kind of thinking that will get us out of it.

People use thought processes all the time to make decisions and solve problems. It is important to realize that everyone has *some* decision-making process, framework, or referent, even if it is unconscious, habitual, or unexamined. Paradigms or habits of thought have a great deal to do with the way we make decisions.

> The world in which our children and their children will live is built, minute by minute, through the choices we endorse . . . These small choices, these trivial decisions, have as much weight

in the long run as all of Napoleon's wars.

—Mihaly Csikszentmihalyi, *The Evolving Self: A Psychology for the Third Millennium.*

Focus on Decision-Making

About 1992, Zimbabwean wildlife biologist Allan Savory hypothesized that the root cause of biodiversity loss, desertification, and declines in social, economic, and emotional conditions could be found in the underlying decision framework that people use, which tends to be linear rather than holistic. An example: many people feel certain that desertification and biodiversity loss in sub-Saharan Africa are the result of one or more of the factors on the left side of the chart below.

In every single respect, the factors that appear to govern the situation in West Texas are the reverse of those in Africa. Yet severe desertification and species decline are also occurring on Texas rangeland. There is increasing conflict over resources. Rivers are silting and flooding, and small rural communities are in decline. Many people—including a significant portion of international aid experts—remain certain that desertification is the result of overpopulation, overstocking, and so on. (See, for example, the United Nations' Environment Programme's publications.) West Texas was chosen because it is flat and privately owned; otherwise many rural areas in the U.S. would suffice for comparison. The point is not that the problems or symptoms on the left side aren't grave and serious. The point is that we are in most cases managing as if the factors on the left are *root causes*.

What the two places have in common is that the decisions are being made in roughly the same way—according to problems and opportunities, past experience, fears and worst possible outcomes, intuition, short-term gain, research results, peer pressure, regulations, compromise, single criteria, *by treating problems as goals*—in short, according to parts rather than wholes. This framework is problem-oriented and reactionary.

Sub-Saharan Africa	West Texas
• too many people	• rural population declining
• overstocking with livestock	• stocking levels a fraction of those in 1910
• overcutting of trees	• mesquite encroachment seen as a problem
• drought	• no bad run of droughts, except for '96
• cultivating steep slopes	• terrain is largely flat
• lack of education	• education is high by most standards
• poverty	• abundance of money
• lack of research and extension	• abundant research and extension
• warfare	• peace
• corrupt administration	• administration uncorrupt by most standards
• shifting agriculture	• stable agriculture
• lack of fertilizer, machinery, chemicals	• plenty of fertilizer, machinery, chemicals
• communal land tenure ("tragedy of the commons")	• land is privately held

Savory's hypothesis is deeply challenging to those who believe that the crisis of sustainability is a modern one, and that its causes can be found in fossil-fuel technology, overpopulation, corporate globalism, or some kind of latter-day greed and ignorance.

This, Savory points out, is our human way of making decisions, and has probably played a role in the collapse of civilizations for thousands of years. This hypothesis is deeply challenging to those who believe that the crisis of sustainability is a modern one, and that its causes can be found in fossil-fuel technology, overpopulation, corporate globalism, or some kind of latter-day greed and ignorance.

The hypothesis also challenges those who believe that prehistoric humans refrained from damaging their ecological environment and lived in some kind of Eden. There is a growing body of evidence that prehistoric humans, using Stone Age technology, were directly or indirectly responsible for wholesale extinctions of large mammals in the Americas and Oceania, as well as for landscape-level changes in vegetation.

In general, it has been the assumption of our society that if we manage the parts right, the whole will come right. Evidence that this is not the case is now coming from every quarter, yet our systems of knowledge and management are still structured around this assumption. We need linear thinking. We need technology. But our overall management needs to become holistic.

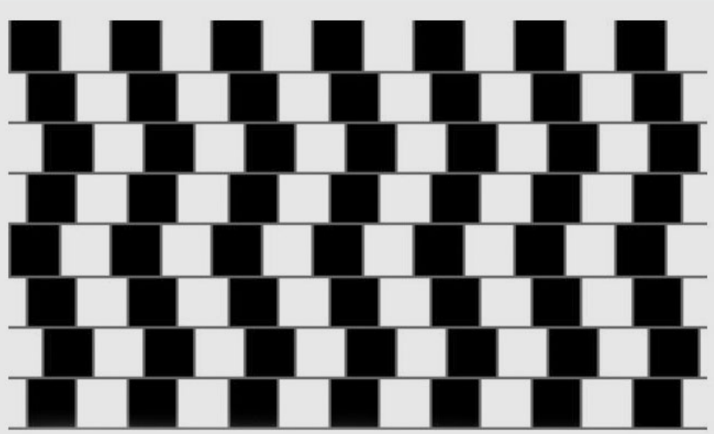
Some ranchers and farmers, some illiterate African villagers, numerous individuals and families, and several nonprofit organizations are now managing according to a single but comprehensive holistic goal that includes their quality-of-life values, forms of production to sustain that quality of life, and future resource base needed to sustain those forms of production. *Ecosystem sustainability is not an add-on criterion to this kind of decision-making—it is built in.* Sustainability is not the result of which *tools* you use—an enormous amount of desertification and soil erosion over the last 10,000 years has resulted from very low-tech tools used by well-intentioned humans. Sustainability results from the kind of *decision-making* you use.

Holism: A Different Paradigm

Wholes have properties that their parts do not have. If you had a roomful of people, half of whom knew everything there was to know about hydrogen and not much else, and the other half knew all there was to know about oxygen, and you showed them water, they would not recognize it. Water is not a compromise between hydrogen and oxygen. Water is not a middle ground. Water is something different.

Holism is the simple but far-reaching idea that wholes are greater than the sum of their parts. This is also the principle of "systems thinking," of synergy, win/win, and abundance. Instead of just dealing with issues or problems, concentrate on *enhancing systems*.

Holistic management recognizes we are in a situation of overlapping wholes. A management whole consists, at minimum, of people with their values, money, and resource base or land. You ask questions that ensure ecologic, economic, and social sustainability in relation to your holistic goal. Examples: is the concern you are dealing with a problem, or a symptom of a deeper problem? Are you dealing with the weakest link in the chain? What action will give you the most progress toward your holistic goal for the least money or effort? You also assume you might be wrong: you monitor and adapt.



Are the horizontal lines parallel or do they slope?

Aristotle represented the trajectory of a projectile as in Figure A, with forced motion shown by the ascending arrow, and natural motion by the falling arrow. We who recognize Galileo's discoveries on inertia and gravity (many of which were paradigm shifts) 'know' that the trajectory of a projectile follows an approximate parabola as shown in Figure B. Aristotle grew up in a culture where spears, rocks, and arrows were commonplace. In many cases he was a keen observer. Yet his concepts and assumptions—the truth of which we recognize—determined what he saw.

A wide-angle view of decision processes is outside the curriculum of most educational institutions or business schools. These kinds of things have only recently come into awareness. Some scientists are realizing the inadequacies of conventional paradigms or assumptions about reality, i.e., that reductionism does not apply to many things. But, as is so frequent in human affairs, there is backlash against the new concepts.

Often we do not recognize the power of paradigms. When someone who doesn't share our assumptions or paradigms doesn't see something that we think is obvious, we often become angry. We think the person is blind, dishonest, corrupt, immoral, stupid, or close-minded.

The Psychology of Change

Few people begin to use a holistic decision-making framework merely from being exposed to the concepts or understanding the rationale for the change. This reflects our human way of change. Often, rationality or demonstrated benefits have very little to do with whether or not change happens.

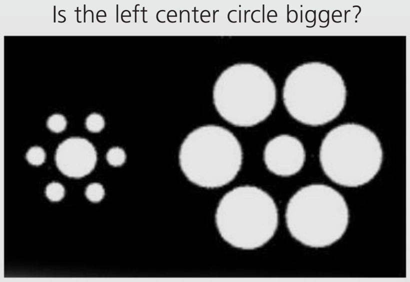
You are not required to accept the perspective of holism as established, proven, certified, researched, commissioned, or even widely accepted fact. It is not an acknowledged majority viewpoint. However, I encourage you to adopt holism as a *working hypothesis*, and to engage these concepts on that basis. In other words, what if the universe functions in wholes? How would you live your life, make your day-to-day decisions?

We cannot achieve long-lasting change unless we deal with the resisting forces—which are often at the deeper level of behaviors and beliefs. Many of our purposes require change or motion at the level of behaviors and beliefs, yet the solutions we propose deal typically with strategies and actions—in other words, with symptoms. Most meetings deal with agendas, strategies, actions, projects, and proposals. Often we focus only on getting people to *act* differently. We nag. We pass legislation. We encourage people to adopt management or political strategies. We spend a great deal of energy trying to shift ideology, priorities, or people's position on particular issues, without regard for the fundamental and underlying decision process itself.

Changing Our Perceptions

Take a look at the image below—is the center circle bigger on the left?

Is the left center circle bigger?



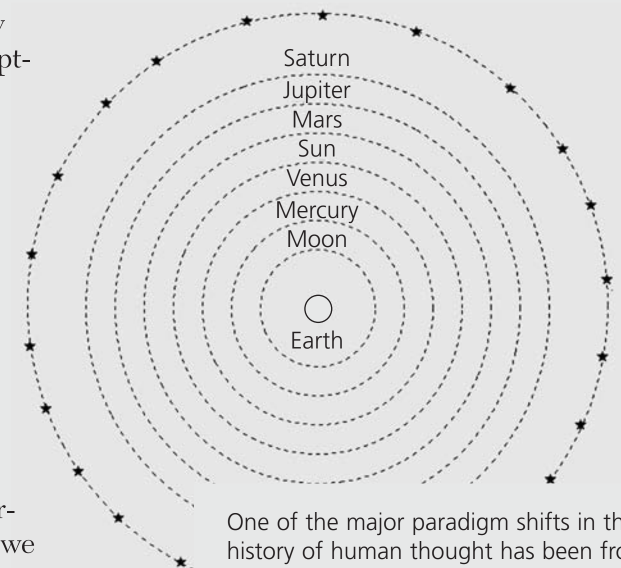
No, they're both the same size.

The visual cues—the rings of outer circles—lead you to see the middle circles as different sizes, when in fact they are the same. The cues lead our perceptions to a false perspective. The image on the previous page also causes perceptual distortion: when you focus on seeing one line as straight, the nearby lines look bent due to misleading cues. (People vary in their ability to shift perspective at will—Dutch artist M.C. Escher's prints will put you to the test, such as his *Convex and Concave*, or *Ascending and Descending*.)

Shifting our paradigms, like shifting our visual perspectives, is largely a matter of cues. Our responsibility for self-education requires that we become aware of the cues that we respond to. These may include childhood scripting, our education, training, and upbringing, and much of what we regard as our habits. In conversation, in meetings, in making our daily or yearly plans, and in all of our decisions, we are responding to cues. The circle image shows that although we are powerfully affected by cues, we do have choices. We can see the center circles as different sizes, or (if we concentrate) the same size. As Ralph Waldo Emerson observed, "He who cannot change his mind, cannot change anything."

Holism is *not* an ideology, political orientation, belief system, or packaged solution. Holistic decision-making—action based on knowledge of wholes—is an ongoing evolution in science, knowledge, behavior, and action at all levels. We don't know the end result of this evolution, but we can guide it with our intentions and choices. The present moment, the present state of affairs, is not the endpoint of that evolution.

Donovan notes that this material was gathered from a variety of sources, including Allan Savory, Bob Chadwick, W. Edwards Deming, Jeff Goebel, Kirk Gadzia, and Roland Kroos. For short descriptions of the nuts and bolts of holistic management, see also www.holisticmanagement.org. For more detail, see* **Holistic Management: A New Framework for Decision Making** *by Allan Savory & Jody Butterfield, Island Press, 1999.



One of the major paradigm shifts in the history of human thought has been from the Earth-centered concept of the universe (planets, Sun, and stars orbiting the Earth—the above drawing) to the heliocentric understanding of the solar system (planets, including Earth, orbit the Sun). Aristotle and the ancient Greek thinkers viewed all the objects in the sky as formed of substances that floated above, like the air. This paradigm was formalized into a detailed model of an Earth-centered solar system by Ptolemy (Claudius Ptolemaeus) in the 2d century AD, which became further engrained in everyone's thinking and supported by their observations for the next 14 centuries. The sun-centered theory was actually first proposed by Aristarchus of Samos (ca. 310-230 BC), but didn't fit well into Greek perceptions (if the earth moved, what kept things from falling off, or being left behind?) and so was discarded. The heliocentric idea wasn't taken seriously until Nicolaus Copernicus worked out some of the details in the 1530s, which was later built upon by Johannes Kepler (who first proposed elliptical orbits), Galileo, Newton, and others. We have since learned that paradigm isn't exactly right either.

Seeing Everything Anew

by Matt Hagny

Kennebec, SD farmer Mike Arnoldy doesn't like to take anything for granted. Whether it's a new piece of equipment, a new crop, a different crop sequence, or what he eats for breakfast, Mike enjoys questioning everything. He views his surroundings with an uncommon lens: always in a new light. While he readily admits to lacking the time to test everything, Mike likes to play with the more promising ideas. Almost 40, Mike says, "I'm not just that young guy trying all these crazy things anymore."

Crazy or not, Arnoldy has been successful, doubling the size of the farm since his dad handed it over to him right out of college. That bit of history isn't exactly typical either, with Mike's dad originally farming at Tipton, KS when he got drafted towards the end of WWII. That brief tenure in the military cost him his leased land, prompting him to look elsewhere for a chance to earn a living. After several other farming ventures and odd jobs, he arrived in Kennebec with basically nothing, and set about pulling himself up by his own bootstraps. Mike continues the tradition, never afraid to forge productivity by his own recipe.

Mike & his dad were introduced to no-till in 1987 by Tim Taylor, a local farmer (and brother of Todd Taylor), and by Dwayne Beck. Mike says they just said a lot of things that made sense, but admits it was a tough sell, especially to his dad: "Here was a successful 75-year-old wheat >>fallow farmer—from Kansas no less—trying to grasp this radical new concept," chuckles Mike. He describes his dad's thought process as he became convinced, "He thought we would for sure have less erosion with no-till. His thinking was that if we go no-till and could make the same amount of money and have less erosion, 'Go for it.' But I was more aggressive—I wanted to make more money, too. In the end, both goals were achieved."

Mike has been essentially 100% no-till since 1990, although during some wet years in the late '90s he ran a tandem disc across some fields very shallow (like 2 inches) to chop up some residue: "During those wet years, we just produced too much residue, and it was getting in our way—we couldn't get fields planted." As we looked at fields on a September day in '02, Mike was noticeably upset that some fields (in certain rotations) no longer had enough residue, with the last few dry years not producing as much.

"Dad thought we would for sure have less erosion with no-till. His thinking was that if we go no-till and could make the same amount of money and have less erosion, 'Go for it.' But I was more aggressive—I wanted to make more money, too. In the end, both goals were achieved."

Mike's soils are undoubtedly unique and quite challenging to farm—mostly Milboro & Promise clays (80% clay) formed in residuum, with some extreme shrink-swell tendencies—super sticky when wet, yet loose and unstructured at the surface when dry, even in long-term no-till. As moisture varies, those soils go from bubble-gum tackiness to talcum powder fluff with four-inch wide cracks—but with a really bad attitude about relinquishing moisture held so tightly by the clay. Regional precip. patterns that bring abundant moisture in the spring, plus a narrow planting window (short growing season), make springtime seeding of these soils a lesson in frustration.

Photo by Mike Arnoldy.

Mike Arnoldy's planting rig. The air cart delivers (separately) two fertilizer products to the planter. Filling and planting efficiency in Mike's operation is measured in minutes, not hours or days.

Seeding Skills

Even in the drier years, some of Mike's fields are extremely slow to dry in the spring, especially in wheat stubble harvested with a stripper head (even worse if it is 2d-year wheat). Getting the tractor across the field isn't so bad now that he's no-till, but keeping everything functioning on the planter (or drill) is a bitch in the mud. Yet he and his hired man, Ralph, know exactly what perfect no-till seeding looks like. Mike tells of once when Ralph called on the radio to say that the planter was working better than he'd ever seen before—the fields had dried enough on top to where it was just right for planting corn. As it turned out, that field was his highest yielding corn, ever. But more typically what happens is he can't get all his intended corn acres planted due to wet conditions.

"You really only get one chance to get it right—everything else you do hinges on getting a stand."

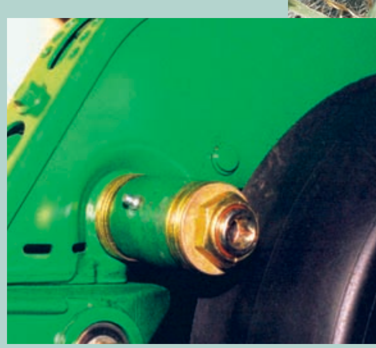
He doesn't dare move much of anything with the Dawn row cleaners, or everything muds up immediately. Last year it occurred to Mike that "the planter just doesn't go through the mud like it used to." Searching for answers, he called about a mud scraper for the gauge wheels. In talking with Phil Kester of R-K Products, he realized that his planter's gauge wheels were no longer staying up tight against the opener blades—the pivot point had worn and gotten loose. Mike quickly ditched the idea of trying scrapers for the gauge wheels, opting to fix the problem at its source with R-K's repair kit for the gauge wheel pivot arm. Although Mike looked at other products to remedy that problem, he's really sold on the R-K kit: "They're four times better than anything else, for half the money."

Arnoldy has run Keetons and spoked closing wheels on the planter for years, but is never quite satisfied with the performance or durability of those components. His Deere 1850 drill has been improved as well, with narrower gauge tires (3-inch) and spoked closing; currently he's evaluating several rows of SDX firming wheels. He continually tinkers with his seeding equipment, explaining how critical it is to his no-till success: "You really only get one chance to get it right—everything else you do hinges on getting a stand."

When Arnoldy acquired his planter, he was still transitioning between a conventional till wheat >>summerfallow operation and a no-till system with diverse cropping. To keep costs down, he took one of his older 4WD tractors, removed the duals, and scooted the inside wheels wider to make a planter tractor out of it. To gain capacity and filling efficiency, he opted to tow a Flexi-coil 230 bu. air cart behind the planter to deliver two fertilizer blends to the planter. While the cost of the cart was high (he originally purchased it for just this purpose—he didn't yet own an air drill), he says he has recouped the cost by covering the acres more quickly. Mike later bought a Deere 1850 air drill to go with the air cart. When all his 2001 winter wheat froze out, he had to gear up to cover even more acres in the spring, resulting in his purchase of a second Flexi-coil air cart so that both seeding rigs could run simultaneously. Filling the air carts from the semi hopper is built for speed too, with radio-controlled Michels fill augers bringing product from both compartments to the center—"It only takes a fraction of the time it used to take with tandem trucks." (For more, see www.michels.ca/hopper.) Arnoldy knows the value of squeezing more productivity from his equipment, since he farms 6,000 acres, with another 1,000 or so of custom seeding. Just he and Ralph accomplish all that, plus the spraying and harvesting.

Agile Cropping

Mike's rotations vary considerably, taking into account a broad range of agronomics, economics, and field conditions. "I don't really have a set rotation, since I never know what conditions will be like at planting time. I really have a tough time talking rotations [as something to be rigidly followed]." Yet he knows well the importance, and strives to discover and make use of good sequences. He has 3 main rotational patterns. Spring wheat >>w. wheat >>corn >>sunflowers is an "old" rotation used on about a third of his acreage. If 'cheatgrass' is bad in a field, he uses only one wheat in 4 years: win-



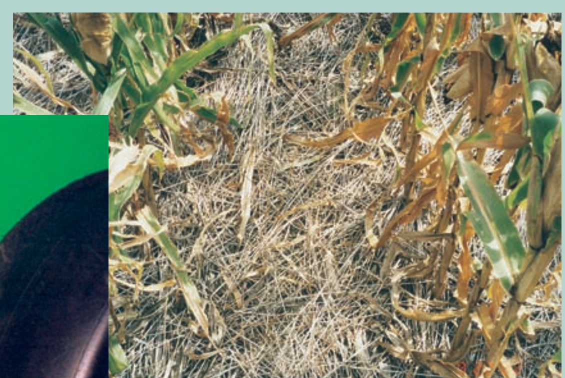


Photo by Matt Hagny.

Planting corn into heavy stripper-harvested wheat stubble on Mike's high-clay soils can be challenging, to say the least. A short growing season and rainy spring weather add to the frustration. Keeping the planter openers from clogging with mud is the biggest hurdle, which Mike is addressing with a new understanding of the opener itself and some low-cost refinements to it. (For one piece of the puzzle, see www.rkproducts.com.)

Photo by Matt Hagny.

Mike's area is marginal corn country, yet it withstood the drought of '02 better than many of his crops. Mike notes, "The garbs made about 1/8 of a good crop, the flowers 1/4, the corn 1/2, and the wheat about 1/3 to 1/2 a crop. The garbs behind wheat were twice as good as the ones behind corn, although still very poor … Flowers were unexpectedly poor, despite timely rain."

ter wht >>corn >>flowers >>proso millet. Mike has been growing lots of garbanzo beans (chickpeas) lately, in a w. wht >>corn >>garbanzo rotation (he once upon a time grew quite a bit of flax in the rotational niche where the garbs are now). It's remarkable how weed-free his fields are, despite growing many crops that have rather limited herbicide options (flowers, chickpeas, millet) and generally no Roundup Ready crops (although he's used RR corn to bring CRP back into production on several occasions, without any tillage).

In assembling his roster of rotations, Mike has tried quite a few variations. He has tried avoiding the problem of planting corn in muddy wheat stubble by putting it behind sunflowers or garbies instead—it sure plants nice; the only problem is the corn often yields next to nothing in those low-residue conditions. He once tried corn on corn, again without much success. Corn after millet seems okay, though—the millet stubble strikes a balance between being heavy enough to hold some moisture and yet plantable during a wet spring. Proso millet isn't really Mike's favorite crop to grow—the market is flaky, harvest is slow, etc.—but millet stubble also makes a wonderful seedbed for w.wht, and the millet can be planted quite late in his area, compared to corn or milo. This is key, since some years the corn just can't be planted on time, and sunflowers can't be grown too closely together in the rotation, due to disease and insect problems. Mike's approach is to try to get the wheat stubble to corn, but if that doesn't happen it goes to flowers—if the field hasn't been in flowers for a few years. If neither of those work, then it goes to millet. As for milo, Mike notes that it is viable for his area, but not in wheat stubble, due to the short growing season: "If I miss the window for planting corn, then forget milo. Missing the window for 95-day corn and replacing it with 100-day milo in wheat stubble is asking for trouble. When milo fails here, it is due to lack of heat units."

Mike stresses the need to keep his options open, refusing to apply fall atrazine that would lock him out of sunflowers. "Some guys around here put Ally on the wheat, but what if the wheat gets hailed out? Then I couldn't do flowers." He does some fall-applied Spartan for the garbs, which would still let him go to flowers if need be. Mike is constantly looking for crops to add to his already diverse rotation. He says the garbs are okay, being more profitable than flax, and allowing him to grow better wheat than behind flowers (but not as good as after flax). He tried field peas once, although he says "they were a lot of goofing around for not much money," and the wheat wasn't that fabulous afterwards—but he suggests that he needs to take another look at them. He is quite familiar with growing milo, although he is still struggling to 'place' it in his rotation—he likes seeding milo after sunflowers, but is puzzled as to what to do after that (2d-year milo, then garbs??). He has tried soybeans, but is convinced they won't work in his soils and climate, which may well be true (in the 'contest' as to who farms in the toughest conditions, Arnoldy's area trumps most everyone else on the U.S. prairies).

New Horizons

As if the wet spring weather, short season, dry summers, and belligerent soils weren't enough, their area has some screamer winds in the early spring—enough to blow away the top couple inches of soil even in long-term no-till, if residue is scarce. While sometimes even his corn stalks tend to blow, such as when they're planted early to garbs, by far the worst is sunflower stubble, which is loose, powdery, and without much residue. Run an 1850 drill through it seeding wheat, and it really wants to go—the stalks are flattened, and the surface loosened further. In '02, he tested one possible solution: planting Indianhead lentils right along with the flowers (he used one of the compartments in

Photo by Doug Palen.

Mike was a stop on the SD No-till Bus Tour in 1996 and again in 2000.

the air tank to deliver the lentil seed to where pop-up fertilizer would 'normally' go on his planter—just ahead of the closing wheels). It was a flop—while he had a nice stand of lentils to help cut wind speeds after flower harvest, they cost him 200 lbs of flower yield. While Mike is ready to discard the lentil idea, he is constantly thinking up other ways to avoid his problem, such as holding the flower stalks for millet or milo, which would get him past the strong winds of early spring.

It seems paradoxical that Arnoldy should have to fight both too little and too much residue, such as the previously mentioned very shallow disking of some of his fields in the late '90s. The answers may lie in improved rotations as much as in steel, although Mike refuses to dismiss any idea prematurely. His main problem with too much residue is in preventing the field from drying enough to get the corn in on time—primarily in very heavy wheat stubble, especially 2d-yr wheat. "The stubble from the spring wheat [from 2 years earlier] is flat on the ground and rotten, and the [previous year's] winter wheat stubble is waist-high—it just can't dry out." Recently, Mike has partially solved the problem by not planting two wheat crops back-to-back on his better fields—"They were always the ones producing the heaviest stubble." He wonders if perhaps he could put garbs between the two wheats, which might help both the garb yield & quality, as well as avoiding the huge straw accumulation from stacked wheat. He's also starting to come around to the idea of seeding a cover crop in some of his wheat stubble, which seems crazy in such a dry climate. Then again, a few more tweaks on the planter might make the problem go away too.

Arnoldy most assuredly keeps an open mind when it comes to all the ideas and trends swirling around today. He's always concerned he might be missing something, or not thinking about a problem in the right way. He's a top-notch observer, and asks thoughtful questions. He knows all too well the limits of any one set of data, or the pitfalls of hastily drawn conclusions. Yet he realizes the risks of delaying decisions while the evidence accumulates—you have a business to run in the meantime. Staying profitable is tough business in this marginal country, although Mike likes time for his family, his woodworking, and his fishing: "Sometimes you just have to get away from all this farming stuff, take some time off, and come at it fresh again in the spring." Enough said.

Photo by Matt Hagny.

Arnoldy's hired man seeding second-year wheat.

No·till On The Plains

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