Biology, Technology And No-Till 'Beckology'

Researcher Dwayne Beck backs biological solutions to biological woes, recommends creative use of technology for planting, fertilizing.

By Dan Zinkand, Managing Editor

As an advocate for no-tilling cropping systems for more than 30 years, Dwayne Beck is adamant about using biological solutions to biological problems.

But as the manager of the no-till-devoted Dakota Lakes Research Farm near Pierre, S.D., Beck also believes in creatively using technology for no-till equipment. However no-tillers use biology and technology, they need to work with Mother Nature while they watch the bottom line, Beck says.

AN ANALOGY. Dwayne Beck, manager of the Dakota Lakes Research Farm, likens soil biology to the diet of a cow. If a cow only eats corn stalks, it won't be healthy. The same holds true for no-till soils, which need varying crop residues to thrive.

"Mother Nature is an opportunist," he says. "If you have a problem, you have been provided the opportunity somewhere in your farming system."

Purposeful Cover Crops

Cover crops are all the rage right now, but Beck urges no-tillers to consider why they want to grow cover crops. During the 2010 National No-Tillage Conference in Des Moines, Beck explained some of the obstacles to no-till and his thoughts on how to overcome them.

"Everybody is running out and saying, 'I want to plant a cover crop,'" Beck says. "If that's all you want to do, fine. But if you don't think about what you are doing, cover crops may end up doing you no good or even doing harm.

"Think of a cover crop as just another component of your crop rotation. It's not anything special."

Beck says cover crops can help no-tillers fine-tune water use, sequester nitrogen so it doesn't go down into drainage tiles, speed residue decomposition, create habitat for beneficial predators, increase organic matter and provide feed for livestock.

"Cover crops and forage crops provide no-tillers an opportunity to increase the intensity and diversity of their system when and where the production of a cash crop would be impossible, unprofitable or excessively risky," Beck says.

Before choosing which cover crops to plant, determine how much risk you can tolerate, he says. "No-tillers are all different in their risk tolerance, so I can't tell them what to do," Beck says. "I had a call from a farmer who was trying to decide whether to grow high-value chickpeas, medium-value peas or a legume green-manure cover crop.

“I said, ‘If you go to Las Vegas and play at the $100 table, then you should grow chickpeas. If you go to the $5 table, you should grow peas.

“But if you go to Vegas, eat the smorgasbord and watch everybody else gamble, you should grow a green manure cover crop because that’s not a gamble.’”

Beck says cover-crop seed should be inexpensive, readily available and produce vegetation that’s easy to kill. He favors using mixes of cover-crop seeds, but cautions that problems could develop with some cover-crop choices.

Like any crop in a rotation, cover crops can promote or decrease problems from certain diseases and insect pests, Beck says. The popular idea of using “cover-crop cocktails” — especially those that include both grasses and broad- leaves — makes this job more complex.

"It’s not how deep you no-till corn, it’s where you put the growing point and how well you can place the growing point …"

“Unless I’m grazing cows on cover crops, I don’t generally want to do a lot of these cocktails with both grasses and broadleaves in the mix,” Beck says. “I think you can get to the point where cover crops with grasses and broadleaves will act as a bridge or host for diseases.”

One of the primary reasons for growing cover crops should be to create beneficial conditions for the next crop, he says.

“Don’t forget about the next crop that’s making you money,” Beck says. “You can get so involved growing cover crops that you forget about the real reason you’re farming, and that’s to make the next crop better, not to screw up the next crop.”

One important reason to use cover crops is to balance the diet of soil microorganisms, Beck says.

“High-carbon plants contain low protein, so you can use cover crops to balance the carbon and protein levels,” he says.

For years, Beck has urged no-tillers who only grow grain to integrate livestock in their farming systems, so it’s natural for him to use an analogy with cows to explain how cover crops can balance soil nutrients.

“If you feed a cow nothing but corn stalks, she will not eat very much and she’s not going to do well,” Beck says. “That’s why corn stalks or wheat straw don’t disappear from your fields. The diet isn’t right for the cows. Think of the soil microorganisms as little cows.”

Like cows, soil microorganisms need a balanced diet, which no-tillers can provide with different crops.

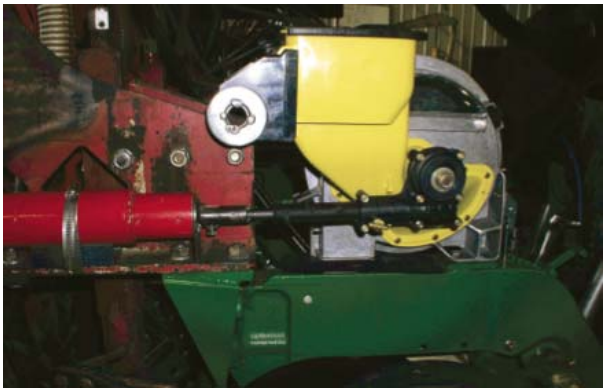
“Cover crops following high-carbon crops are normally legumes or other high-protein crops,” Beck says. “Legume and other broadleaf cover crops grown behind the high-protein crops are often high-carbon crops.”

There are exceptions to this, which mostly depend on what crop will follow the cover crop, Beck says. Cover crops also create a canopy, which increases the humidity surrounding the residue. Plant residue decomposes quickly when humidity levels increase.

"There's good evidence from research that University of Wisconsin plant pathologist Craig Grau did that if you plant a winter wheat or winter-rye cover crop between corn and soybeans in a corn-soybean rotation that this will decrease the white mold," Beck says. "The cover crops cause the white-mold spores to germinate early in the spring, before soybeans are planted.

"By the time you plant soybeans, the white-mold inoculum has been reduced significantly."

Planting cover crops between a rotation that alternates corn and soybeans can provide benefits, but Beck says there are major problems with rotations like this.



ELECTRIC POWER: The use of electric drives like the ones used on the Dakota Lakes' planter will increase on planters, fertilizer rigs and tractors. "Electric drives are easy to control and you can network them into computers," says Dwayne Beck of the Dakota Lakes Research Farm in Pierre, S.D.

"The stupidest rotation in the world is growing the same crop every other year because it's so predictable to insects, weeds and disease," he says. "Look at your rotation and consider it from the perspective of an insect, in terms of sequence and interval.

"You have a chance of getting an insect problem by growing the same crop every year or every other year. The same thing holds true for weeds and diseases."

Fixing A Leaky System

One of the most important functions of cover crops is to help no-till mimic natural water cycles, Beck says. No-till is essential to mimicking natural water cycles because it reduces runoff and improves water infiltration in the soil.

A good place to start understanding the task of balancing the water cycle is to gather rainfall data.

"You can create a spreadsheet of how much water you receive," Beck says. "Then go to the USDA's Web Soil Survey Web site to find out how much water your soils will hold.

"Then you can say, 'I'm going to harvest crops at this time of year and if my soil is totally dry, what do I need to do to manage normal, less-than-normal or above-normal rainfall?'"

If the current cropping systems aren't using all of the water in the soil, the water table will rise or water and nutrients will leach, Beck says. This is not a good way to produce crops and protect the ecosystem.

In natural systems where leaching occurs, the native vegetation is normally trees.

"The function of trees in these systems is to draw water and nutrients from deep down in the soil where grasses and annual plants can't reach them," Beck says.

When Beck visited Australia recently, he recommended that wheat and canola growers add a cover crop in the summer to use some of the water that escaped the cool-season crops grown in the rainy, cool winter. Rainfall exceeds water use during the normal growing season for these crops in Australia.

The shallow roots of wheat and canola will not use the water and nutrients that move deep into the soil during the winter. This will cause the water table to rise and salinity to develop, Beck says.

He suggested the Australian farmers grow a summer cover crop so the summer heat would extract water and nutrients from deep down in the soil. Then the water would evaporate and the nutrients would be deposited in the surface of the soil where the next crop can use it.

"If you have a problem with nutrients, your mineral cycle is messed up," Beck says. "If your pH levels are dropping, it's because your cations are leaching out.

"The cropping system is not sufficiently intense to cycle nutrients properly. You have a very leaky system."

"If you recycle the nitrogen up in the soil profile, the pH level doesn't go down and you get to use the nitrogen ..."

— Dwayne Beck

It's not uncommon for Australian fields to be low in potassium because it leached below the root zone of annual crops, Beck says. The potassium-deficiency symptoms are often mistaken for drought damage. No-tillers should ask if problems like this result from mineral cycles that aren't functioning as they should.

Beck adds that elevated levels of nitrate in the river water that the city of Des Moines uses for drinking water results from poorly managed water and mineral cycles.

"The nitrate that's going into the Des Moines' water system needs to be cycled back to the top of the soil in farm fields," he says. "Cations are also moving with the nitrates and that makes the pH level go down.

"If you recycle the cations and nitrogen back up in the soil profile like the perennial grasses in that area once did, then the pH level doesn't go down and you get to use the nitrogen."

Beck says an experiment in Iowa that has used boxes of wood chips to absorb, denitrify and sequester nitrate from water flowing through drainage tile lines doesn't fully account for water, mineral and energy cycles. While the wood chips absorb some of the nitrate, the denitrified nitrate is released into the atmosphere as nitrous oxide. Beck adds it's better to use the nitrate as fertilizer.

This well-intentioned method of improving water quality also creates air-quality problems that can contribute to climate change, he says. The Environmental Protection Agency would be concerned about nitrous-oxide emissions from wood-chip nitrate collectors if they were used on a large scale, Beck says.

No-tillers typically install drainage tile to eliminate cold, wet soils in the spring. But before they spend time and money tiling fields, Beck recommends cover crops as a possible solution.

"If you plant corn in April, it will start using water seriously by about June 1," he says. "The best soils in the world hold about 12 inches of water. Corn quits using water sometime in the middle of September. How much precipitation do you get between mid-September and June 1 of the next year? Way too much.

"You need to find ways to use that extra water. You've got to change your rotational intensity."

In the short run, no-tilling with the same crop rotation as what was used with tillage can increase the amount of excess water, Beck says. The rotation will not use the extra water that no-till saves, he explains.

Cover crops and forage crops may be able to use this water and increase profits for farmers.

In some locations, no-tillers could plant a nitrogen-producing cover crop between soybean harvest and corn planting, Beck says. Cover crops could also increase the population of predator insects and help farmers reduce the crop inputs they buy. Balancing nutrient cycles and adding organic matter will provide great long-term benefits.

Building The Soil Profile

In fields where topsoil washed down from hilltops, no-tillers can haul the soil back up to the top of the hills, but Beck says it's unlikely that this is economically viable.

He recommends taking the stover from the bottoms where tillage and water erosion has deposited most of the organic matter and nutrients and placing it on the hills.

Bales of hay and straw also can be placed on hills during the winter to feed livestock. The cow manure and the carbon from the hay and straw will help rebuild organic matter on these hilltops.

Beck says this is a concrete example of how no-tillers can use biological solutions instead of mechanical ones to improve profitability, enhance soil quality and use less commercial fertilizer.

No-Till Equipment Solutions

Beck is as much an equipment wizard as he is a believer in working with biology.

Many no-tillers don't apply fertilizer when planting because they don't want to stop to refill fertilizer tanks, Beck says. But it's possible to efficiently refill fertilizer tanks by copying a common practice in the construction industry — that is if the ag-machinery manufacturers want to develop this concept.

A truck drops off an empty container for debris at a construction site, picks up a full one and leaves without the driver ever getting out of the cab, he explains.

"We could place full fertilizer containers ahead of the field we're planting in," he says. "I could no-till 20 or 60 acres, then just drop off the empty fertilizer container and pick up a full one. The empties could be refilled and spotted at the next field."

Beck believes electric drives will play a larger role in operating agricultural equipment. Many no-tillers worry about corn stalks grabbing the drive chains on their planters. Not Beck. Electric drives control every row on the Dakota Lakes' planter, so there are no drive chains.

"Electric drives are easy to control and you can network them into computers," Beck says.

Using electric drives allows no-tillers to place singulation units where they want them on a planter. Beck predicts that electric drives will replace or improve the air-delivery system of dry fertilizer.

“Air is too inefficient, but if it’s going to be air-driven, it will be electric-driven air,” Beck says. “It’s not going to be hydraulic because hydraulics are too inefficient. They have oil that spills and the EPA doesn’t like oil spills.”

Most no-till equipment today has come from modifications to conventional equipment, Beck says. He advises no-tillers to do whatever works best on their planters, as long as seeds are covered with loose soil.

“You want that plant to perceive light at the right place so it sets its nodal roots in the right place,” Beck says.

Too much residue and/or soil packed tightly over seeds cause problems, Beck says. Corn seedlings perceive light later than needed, which slows emergence.

If corn is planted too shallow, the growing point will be too close to the surface. That makes seedlings vulnerable to damage or death from frost, he says.

“It’s not how deep you no-till corn, it’s where you put the growing point and how well you can place the growing point,” Beck says.

Managing Tough Residue

With tough *Bt* corn stalks and increasing amounts of residue from continuous corn and higher yields, many no-tillers struggle to keep wires, hoses and chains from being damaged and knocked off planters. Beck suggests a “South Dakota solution.”

Take a small piece of rebar and hook it in the fertilizer openers, he says. After that, take a piece of pipe and hang it there. These additions will get all the corn stalks leaning the right way.

Beck says this is a better, lighter alternative to managing residue than using combine-header attachments.

Beck likes residue managers, but says they may need modifications to improve performance and create better stands. He welded harrow tines onto Yetter residue managers, and then angled the residue managers so they move residue to both sides of the rows.

Beck says it’s important to press seeds firmly into moist soils. Some no-tillers use seed firmers, while others just use closing wheels.

“You can press seeds into the ground with a Keeton seed firmer, but if you do it right with a Keeton, you wear them out real fast,” Beck says. “I like a vertical closing wheel better, but that’s hard to do on a standard corn planter.

COMMENTS: 1

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Posted from: Philip Sandoval, 10/15/12 at 11:28 AM CDT

Good stuff. Beck will be speaking in Billings MT Nov 28th. I am looking forward to more details on his work and what he has learned at the farm.

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