

Diversity is King

North Dakota Farm Combines Cover Crops for Improved Soil Health, Fertility and High Yields

by **Gabe Brown**

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The farm we're on today was purchased from my wife's parents back in 1956. They farmed conventionally—tillage, heavy tillage, half summer fallow, half small grains. They primarily grew spring wheat, oats, barley, and, once in a great while, flax. So it was primarily cool-season grasses, half summer fallow, half crops. They also had a small cow/calf herd up until the late '70s. In 1983, when I finished college, Shelly and I moved onto the place and entered the cow/calf business. Her folks were still operating the grain farming aspect of the operation, and we did the cow/calf enterprise. Both my wife and I worked in town. During the late '80s, we started dividing up the pastures a little bit to do some rotational grazing, as there were only three pastures on the operation when we arrived. That was our first foray, so to speak, into rotational grazing.

In 1001, we had the chance to buy the home place from them—they had retired and moved to town. For the first two years, I farmed conventionally, with tillage. We're in an environment where average precipitation here on the outskirts of Bismarck is about 15 inches, but of that, 9 inches comes as rainfall and the remainder is from snow. I always thought that moisture was the limiting factor in crop production on our farm. I had a friend in the northern part of the state who was a no-tiller, and he talked me into trying no-till to conserve moisture. He told me, "Gabe, if you're going to go into no-till, sell all your tillage equipment. Otherwise, you'll be tempted to go back." So, I actually did that. We sold all our tillage equipment before I bought a no-till drill in 1993. We bought a 15-foot John Deere 750 no-till drill, and we've been 100 percent no-till ever since.

The first year with that no-till drill, I seeded some peas for the first time, and I began seeding some acres down to alfalfa. I started to diversify the crop rotation a little bit, but I didn't have any idea where it would lead me. What really changed for us was in 1995. We had 1,200 acres of wheat—I should mention that the farm we're on was about 2,000 acres of cropland, with another 3,000-plus acres of tame and native pasture, so it's a little over 5,000 acres altogether. The day before we were going to start combining the 1,200 acres of spring wheat, we lost 100 percent of our crop to hail. That's a pretty tough pill to swallow. Because it had only hailed once on this farm in the previous 25 years, we didn't even think of taking out crop insurance for hail, because it just never happened here.

You know it's pretty bad when the USDA sends people out from the national office to take pictures. But I was already done combining peas before I lost my spring wheat crop, and that made me realize the importance of having a diverse crop rotation. After the hailstorm, I decided that since we had those nutrients in the soil, let's put some crop on there to grow forage for the



livestock, as that hailstorm also took all of our pasture. That was really my first try at what today we call "cover crops." I seeded some millet and some Sudangrass just trying to grow forage.

In 1996, we started planting corn, and we planted more acres to peas. Obviously, when you're young and starting out, and you lose the majority of your crop to hail, you have a tough time making payments. I couldn't borrow as much money for inputs, so I wondered, "Okay, how do I supply nitrogen without having to purchase synthetic fertilizer?" So, I seeded acres to alfalfa, more acres to peas, and planted more forage crops such as Sudangrass and millet. I didn't know at the time, but what I was really doing was laying the groundwork for crop diversity by diversifying the crop rotation. I had all these other crops along with spelt and spring wheat, oats, barley, and what happens, but we lose 100 percent of our crop to hail again.

Well, that was really devastating. My wife and I both worked off-farm jobs to help pay the bills. With two young children, things were tough. But after that second hailstorm, I started to plant more mixes just to provide forage for the cattle. One of the combinations I tried using was winter triticale and hairy vetch. At that time, soil health was not even on my radar, I was just trying to save the farm. But really, what I was doing was building a foundation for advancing soil health.

In 1997, we started to diversify the rotation even more, but that year was a total drought—nobody around us combined an acre, including us. We had three years of crop failures in a row. I started planting more of the warm-season species crops—Sudangrass and millet, and I added cowpeas, because I couldn't afford to buy nitrogen, but I knew if I grew a legume with these species, it would fix nitrogen for those grass species. So, we started to grow some crops in combination. 1998 came along, and we lost 80 percent of our crop to hail again. So, I lost the majority of four crops in a row, and my wife and I will tell you that was absolutely the best thing that could have happened to us, because it changed the way I look at production agriculture.

I noticed that following the peas, the next crop was a little better. Following the diverse Sudangrass/millet/ cowpeas, the next crop was a little better. Following the triticale/hairy vetch combination, the next cash crop was a little better. We started to notice our organic matter percentages improving, and I should note that we were fortunate that we were soil testing. My father-in-law had soil tested for years, and I soil tested, so we had the

baseline data. When we purchased this operation, our organic matter levels were 1.7 to 1.9 percent.

Those levels are typical of land that has endured a consistent regime of little besides synthetic nitrogen for decades. And it's more so indicative of the tillage and of lack of diversity in the cropping system. Those two things especially cause the degradation of soil organic matter. So, our cropland was 1.7 to 1.9 percent. I noticed after four years of drought and hail that we were still about to inch up that up. Obviously at that time, I didn't realize what I was doing, but today I know I had more roots in the ground. Approximately two-thirds of your organic matter increase will come from roots. Well, by growing all these cover crops, adding diversity into the crop rotation, we were seeing an increase in organic matter, so that was a good thing. I had severely cut back on my use of commercial or synthetic fertilizer, and today I know that benefits soil biology. Back then, I had no idea. I was just trying to survive, to feed the livestock, to produce something that would generate cash flow. That was it. Back then, I had no inclination as far as advancing healthy soil. I didn't realize at that time that my soils were in a degraded state.

We ran 100 to 150 cow/calf pairs back in the mid-'90s. Just as a point of reference to where we are today, on basically the same land base, we now run 350 to 400 cow/calf pairs. That's a constant. We keep our cow herd levels the same, then we run anywhere from 300 to 600 yearlings on the same land base. We finish some on grass, so we actually keep some of those animals until they're 28 months old. We have significantly more livestock, plus we have a small flock of sheep, and we're running pastured poultry. My son has an egg-laying business with pastured laying hens, and we have a few turkeys. We've really diversified the operation tremendously on that same land base. I just received my latest soil tests last month, and our organic matter levels were from 5.3 to 6.1 percent on those same fields that once were 1.7 to 1.9. So, we've more than tripled our organic matter levels.

When we purchased the operation, I was very fortunate that the USDA's Natural Resource Conservation Service came out and did a soil infiltration study. What they found is that we could only infiltrate half an inch of water or moisture per hour. And that was because of all the heavy tillage and the lack of soil aggregation and pore spaces. The last test they did at my place over a year ago indicated that we can infiltrate over eight inches per hour. That's a 16-fold increase. I tell people that even though we're in what some might consider a moisture-challenged environment at 15 inches, it doesn't matter how much rain you get, it's how much can infiltrate into your soils, and then how much you can store. It's the organic matter that improves the water-holding capacity of the soil. For every one percent increase in organic matter, that results in approximately 20,000 gallons more stored water per acre. So, when my soils jump from less than two percent to six percent, think of how many thousands of gallons of water I'm able to store in my soil. And that's just from a moisture standpoint.

After 1998, I had lost four crops in a row to hail and drought. We were able to hold on to the beef cow herd, and I was very fortunate that the bank did not foreclose on me. We were still able to make our interest payments, so they stuck with us. I had begun to see a real change in the soil.

It was about then, 1997 actually, when I was first exposed to holistic management. I heard Don Campbell from Alberta talk about holistic management, and that got me thinking about

making my operation function as a whole. So often in agriculture today we segregate the corn crop from the soybean crop, and we segregate that from the livestock enterprises—everything is segregated. I got to thinking about the changes I'd seen in my operation having to do with diversity. It really struck home that what I was trying to do was imitate native rangeland. When you go out in true native rangeland, it's very diverse. My son teaches range management at the local college, and once he brought his students out to one of our native pastures, and in two hours they counted over 140 species of grasses, forbs and legumes. That's tremendous diversity. Don Campbell talked about holistic management, about how everything works together, and how you can't change one thing without affecting another. The hail and drought made me diversify my crop rotation by growing forage crops—Sundangrass, millet, cowpeas—I was putting livestock back out on the cropland. For me, that was really the foundation of holistic management.

So, from the late '90s to right after the turn of the century, I expanded the use of cover crops on my system, and by that time I called them "cover crops." Whenever I harvested a pea crop, for instance, I always immediately seeded something else. I started reading a lot about soil biology and what happens in the ground. We never used to see an earthworm on our land. Then, the combination of no-till, cover crops and the residue I left on the surface to protect the soil had us seeing earthworms in all our fields. I was fortunate, too, when our district soil conservationist at the NRCS, Jay Fuhrer, took an interest in what I was doing, and asked me to serve on the soil conservation district board. As a board, we delved into soil health. It was then that no-till really took off in our county. I was one of the first no-tillers in the county. Today, Burleigh County is at least 75 percent no-till.

We saw a real expansion of people interested in no-till. Then, in 2003, I had the good fortune of meeting Dr. Kristine Nichols, who came to work as a soil microbiologist with the ARS station in Mandan, North Dakota. Dr. Nichols did some of the original work on glomalin with Dr. Sarah Wright out of Beltsville, Maryland. Dr. Nichols came out to my place in 2003. She walked in my fields and said, "Gabe, you've come a long way, but your soils will never be sustainable unless you remove synthetic fertilizer completely." By then, I had backed way, way off any synthetic fertilizer usage, but I was still using some.

So, from 2003 until 2008, I did split trials in several fields on our operation. I would put down some synthetic fertilizer, albeit at a much lower rate than recommended. And then on the other half of the field, I'd put no synthetic fertilizer. For four years in a row, the unfertilized yields were equal to or greater than the fertilized. The last year we used synthetic fertilizers on our own land was in 2008, yet my yields have significantly improved.

Another big learning curve moment happened in 2006, when I spoke at a the "No-till on the Plains" conference in Salina, Kansas. Dr. Ademir Calegari from Brazil also spoke at that conference. He talked about these cover crop cocktails or polyculture cover crops in Brazil where they mix many species together. I was growing two- and three-way mixes, but Ademir was talking about seven-way mixes and above.

I came home and immediately started to diversify the cover crop mixes. That's been a real learning curve in itself, finding out which species work best with each other. Nowadays, rarely do I

seed a cover crop blend with less than 15 species in it. Most of the time, there are at least 20 different species in a blend. I've found that we've really been able to increase organic matter and improve soil health. We get so much greater production when we put these cover crops together.

The next big learning moment in my journey happened in 2006, up in Brandon, Manitoba at a grazing conference. A gentleman came up after my talk and said I had to see what he's doing. It was Neil Dennis from Wawota, Saskatchewan. Neil is a mob grazer. Now, at that time, we had already ratcheted up to what I considered high stock density, 200,000 or 300,000 pounds of liveweight animals on an acre. We moved our cattle once per day. But Neil said we needed higher stock density, and we needed to move them more often. That spring I went to Neil's, because I had to see for myself, because I just didn't there would be much difference between moving them once per day, and moving them several times per day. After seeing what Neil was able to achieve soil health-wise with these higher stock densities of 600,000 to 700,000, even 1 million pounds of beef on an acre, I came home and told my son this was the next step in soil health for us, but not only on pastures. We'll do it on cover crops.

You look at how prairies were formed, with large herds of grazing animals, bison, elk, and deer, moving across the prairie, trampling litter down onto the soil surface. They left their dung and urine, and then moved away, not to return for maybe a year. I wanted to mimic this on my cropland, because Neil had proven it could be done. Allan Savory, of course, had proven it could be done on rangeland, but I didn't see anybody doing it on cropland. I got to thinking about all these cover crops I'm growing, and what we lack in for improvement of soil health on cropland is the livestock component. So, I came home, and my son and I immediately started growing these cover crops, putting high stock densities—600,000 to 700,000 pounds of beef, liveweight—per acre on this cover crop, then rotating them. What we see is an absolute jump in health and improvement of our soil resources.

We've been able to document this with Dr. Ray Ward at Ward Labs in Kearney, Nebraska, and Dr. Richard Haney, who is a soil scientist with the ARS station in Temple, Texas. Haney has developed a test that doesn't only take into account the chemical and physical properties of the soil, it takes into account the biological processes happening in the soil.

Dr. Haney and Dr. Wood just formed an agreement, and now do the test. I believe it costs \$49.50. It's called "The Haney Test," and it's available commercially through Ward Labs, which is really exciting. The beauty of it is that it shows the one thing I think has been missing in production agriculture for many years. We know that after a legume crop, you get a nitrogen credit, but no test out there has really shown the amount of nutrients that we can expect from biological activity in the soil. The Haney test does that now—it is giving a credit for the biological activity. There are some specific protocols you need to follow in taking the soil sample. I see this is a huge step in cutting back the use of all these inputs and fossil fuels in production agriculture.

Over the past several years, we proved that by bringing cattle onto this cropland, we're able to take organic phosphorus and other elements ordinarily not available to plants and make them available. Because of this, our proven corn yield now is 127 bushels per acre. That may not seem high to some, but the

county average in Burleigh is under 100. So, I'm over 25 percent higher than that, yet I have zero fertilizer cost, I have no fungicide, and I have no pesticides. We're down to about one herbicide pass in two or three years, depending on the crop rotation and which fields we're using. I tell people I'm striving to get to where I eliminate all my herbicide uses totally, but I will not use tillage to do that. To me, tillage is just too detrimental to the soil health.

I think we can build topsoil much faster than some scientists suppose, especially when we practice holistic management—integrating livestock, cover crops and diverse crop rotations. Glomalin is the glue that holds these soil aggregates together. We're able to see on our operation that as we increase organic matter, we're building new topsoil. I was familiar with it, but once Dr. Nichols came out here, then of course, my learning curve jumped. I tell people that I'm not really that intelligent of a person, I just had the good fortune of meeting a lot of different key people at the right times to influence our operation, and then it was just a matter of my family and me taking the information we received from all these people and putting it to work.

The one thing that probably influenced me more than anything was Thomas Jefferson's journals. Jefferson, on his plantation, talked about using crops such as hairy vetch, radish and turnips. Back then, he was doing all the things I'm doing now. I tell people that I'm not ahead of the game; I'm really several hundred years behind. It's just that agriculture went full circle. That probably influenced me more than anything because I looked at how production agriculture took place years ago before they had synthetic fertilizers. Four years of financial hardships forced me to go back to those methods. Now, I fully believe that it will be the wave of the future for production agriculture. Let me explain why. I spend a great deal of time in the winter traveling around the United States, Canada and other countries speaking about what we're doing on our operation. I show them my cost of production to produce a bushel of corn. This past year in 2012, my total cost of production to plant the corn, harvest it, store it, haul it to market, land cost, equipment cost, everything, was \$1.47 a bushel. I tell people corn can drop to \$2 a bushel, and I'm still going to make money.

I spoke in Indiana this past winter, and a banker came up to me after he saw that slide. He said, "Gabe, if corn drops below \$5, half of my borrowers won't be able to make their payments." I thought, wow, look where we've gone in production agriculture. We're so reliant on synthetic inputs. If we would do away with that, and focus on soil health, we would lower the cost of production. I've proven it on my operation, and there are many others around the country. Look at what David Brandt is doing in Ohio—consistently growing 220-bushel corn with no synthetic inputs, just cover crop usage.

So, I know this can take place anywhere. It's simply a matter of getting off that tractor and focusing on soil health. I tell people, "We have come, as producers, to accept a degraded resource" because all of our soils are degraded. My soils, even knocking near 6 percent organic matter, are still degraded soils because I have native prairie soils that are at 7.3 percent. I'm not nearly back to where we were before the native prairies were tilled. We as producers have to focus on regenerating our soils. I get so tired of the new cliché, "sustainability." Why do we want to sustain a degraded resource? It makes absolutely no sense to

me. We need to be regenerative. We need to regenerate our soils, and build them for future generations.

We raise grass-fed beef and market that to consumers. I mentioned my son's egg-laying operation, and we have a pastured poultry operation. Everything coming out of those gets marketed direct. The grains we're producing right now, because I'm not organic, are marketed by way of conventional means. We haven't used glyphosate on our operation in five years—and I refuse to use it—and we don't use any GMOs. I also refuse to use them. The majority of the grains are going into the conventional system. Now, I'm working on how to eliminate that last herbicide pass which I use every two or three years. When I can eliminate that, then we will be into the organic system.

I probably average 15 to 25 calls a day during the summer from producers around the country asking questions about what cover crop they should use. I always tell them I will not make recommendations on what you use on your operation, because, honestly, I believe people need to try for themselves. When I go out and speak during the winter, I always get asked, "Gabe, tell us some of your failures." I say, "No, I'm not going to tell you my failures because they might not fail on your operation." My son and I have a saying on our operation—we want to fail at several things every year. I'm serious about that, because if we don't try new things, how do we know what's going to work and what doesn't?

For instance, a young producer from northeast Colorado came up to me a couple of years ago, and he said he'd heard my talk about diversity, and thought it made sense, "but how do I get my father and grandfather to try something else?" I asked him about his crop rotation. He said, "Well, since 1927, we've never planted a crop other than wheat." I thought, my goodness, now that's dead soil.

To answer your question, what did I recommend to him? Well, all that land has had is cool season grasses for almost 90 years. He needs to diversify. There are four main types of crops. There is warm and cool season, broad leaves and grasses in each type. He has a cool season grass in wheat, so what we needed to do was go in there with those three other species. Obviously, in northeast Colorado, it's very hot and dry. Let's go in there with a species that can handle the heat. We went in there with cowpeas, a warm-season broadleaf, plus Sudangrass and millet—both warm season grasses. We also added into the mix some radish, which is a cool-season broadleaf, to get a deep taproot in there. When I work with producers, the first thing I ask them about their resource concern. In the Colorado gentleman's situation, he had no diversity. Because of that, we're going to get a very diverse mix—we added several other things to the mix.

This year a lot of people in northern North Dakota have an excess of moisture, so they have all this trouble with water. That's their resource concern—excess moisture. Okay, you have to plant something to use that moisture. Then you have to plant species that will improve the infiltration in your soil. You need those deep taproots—things like sunflowers and radishes. We have to be able to move that moisture throughout the soil profile.

When I speak back east, there are a lot of people with heavy clay soil. Same type of thing there, they can't infiltrate that moisture, they need to build soil aggregates. We need to go into those soils with deep taproots, but we also have to go into those

soils with things like Sudangrass, which has a very prolific root system. Phacelia is a broadleaf crop used widely in France, and it has a tremendous root system. Rye, of course, is good. Whatever your resource concern is, that's going to dictate the mix and species of cover crops you use.

Of course, it varies region to region in the country. Crops I grow up here can't be grown down south, and vice versa. So, we have to tailor it to each specific region of the country. Too many times, people think of cover crops as a cure-all, like making soup—you throw in whatever is in the refrigerator. It's not like that at all.

You really need to put some thought into it, or it can backfire. I'll give you an example of that. I had a call a year ago from a producer in South Dakota, and he said, "Gabe, you're that cover crop guy. I've got a problem here, and I want to know what you think." He said he had a winter wheat crop on irrigation, had combined it, baled the straw, and then seeded it to turnips and radishes before putting his cattle there in the winter.

I said, "Let me guess, you have no residue and your soil are blowing?" He said, "That's exactly right." I told him it only makes sense. The nitrogen that was left from that wheat crop was absorbed by the radishes and turnips. When they break down, they're going to release the nitrogen, and that's going to accelerate the decomposition of what little residue he had left. He'd just compounded the problem of erosion on his operation.

There are a lot of seed salesmen out there who are extremely good, but some are just out there to make money. You really have to be careful when you put these cover crop blends together, because it can have dramatic impacts on your soil for years to come. Having said that, though, there's much, much more upside potential from planting a cover crop than there are negative aspects of it. I strongly encourage everyone to consider planting cover crops. Just be careful, and do some serious planning before you do.

The thing is, every situation is unique, every farm's soils are unique, every person's resources are unique, thus their crop rotations differ. Some have livestock, some don't. It's almost to the point they must be tailored individually to each person.

Yet, it's really not that difficult either. All we have to do is follow nature's template. Nature's template is a lot of diversity, and you have to integrate livestock. And along with livestock, I don't mean only cows and sheep. I'm talking about insects, also. If we would just step out of the way, and let nature take its course, there are so many symptoms that we producers wouldn't be facing today. For instance, look at fungicide use today in production agriculture—they're using it like water. Most producers are spraying fungicides every year. Instead, they should ask, "What makes a plant susceptible to a fungus?"

Well. What makes it susceptible is probably a lack of micro-nutrients, or a micro-nutrient tie-up. Lots of times it's directly related to the herbicides we use. If we could focus on soil biology and soil health, that soil biology would make those micro-nutrients available, and you wouldn't need a fungicide. I haven't used a fungicide on my operation in well over a decade. That doesn't mean that I don't have fungal diseases, but they never reach the point that they're economically detrimental to me.

Another concern I have is the use of insecticides. If producers would build the habitat for the predator insects to prey

on those insects that are economically detrimental, they wouldn't need to apply an insecticide. Instead, we're at the point in production agriculture where we only see monocultures—we have very little crop diversity, thus there is no home where these predator insects can live. That's one side benefit to cover crops. When we design these cover crop mixes, we're always adding flowering species in there—one, to attract the pollinator, two, to be a home for these predator insects. My son and I always try really hard to focus on solving problems, not treating symptoms. If we could get to the root cause of the problem, and focus on solving that problem, these symptoms tend to go away.

Monoculture is the original sin of modern agriculture. I've proven that time and again. For instance, I mentioned growing triticale with hairy vetch. I had a field here a number of years where we ran out of hairy vetch seed. Part of the field was hairy vetch/triticale mix, and the other part was just straight triticale. We took that off as forage the next spring, as dry hay, there was a 10 percent difference in crude protein. It was higher, obviously, where there was hairy vetch, the legume. It also yielded over 35 percent more. I mean, it's a win-win situation.

You look at the monocultures in production agriculture today, it doesn't make any sense. Where in nature do you find a monoculture? Only where man put it. Now, obviously, there might be a little piece here or there that's a monoculture, but I'm talking in general terms, you just will not find it. I honestly believe one of the biggest detriments to society today is the current farm program and RMA, the Risk Management Agency. They're not allowing us to do intercropping, and we're not allowed to grow cover crops with the cash crop. On our operation, we try to never seed monocultures. We always want a diverse mix in every field.

But yet, in saying that, it's going to kick you out of crop insurance, because crop insurance won't allow it. But I don't care anymore. I don't take out much crop insurance, because to me, I'm just betting against myself. I think I've built up enough resilience in my soil that I don't need to take out crop insurance. We can weather droughts even though we don't have irrigation.

Some people ask if harvesting those diverse fields isn't very labor intensive. Sure it is, but that just comes down to planning what combinations you use. For instance, one I've been using for a number of years in my corn, I will have low-growing clover in. That low-growing clover, whether it be red clover, or subterranean clover, or something like that will stay below the ears of the corn, so it's not going to interfere with the harvest whatsoever. Last year, for example, we grew an oat crop with three types of clover seeded along with it. When I straight cut the oats, clovers were not as tall, and oats yielded 115 bushels per acre. I was left with a growing clover cover crop and living roots feeding soil biology.

There's been some good work done by guys who are actually now growing peas and canola together, because they are easily separated. A good friend of mine, Owen Carnes, up in Saskatchewan, is doing this with great success. He's growing peas and canola using pretty much a full seeding rate on each, and going in and combining it, then he is able to run it through a cleaner and separate it out easily. It's netting him substantially more dollars per acre than a monoculture.

The thing of it is, we're getting much, much more production per acre. I get really tired of the question, how are we going to feed 9 billion people by the year 2050? It is absolutely no

problem whatsoever if we diversify. Just drive anywhere in this country; you're going to see monoculture field after monoculture field. How many acres upon thousands of acres do you see with no fences on it? On our operation, we grow a cash crop, we grow a cover crop, grass-finished beef may graze it, pastured poultry may graze it, we have guys bringing in bees to take advantage of those flowers on that cover crop, so we're producing honey.

There are myriad opportunities if we stack enterprises. Why should we settle? I can use any example, but say for instance in the corn belt, why should we settle for just 200 bushels of corn off that acre? Why can't there be livestock added on top of that? It's foolish for us to even think that we're not going to feed that many people. To me, that's just industrial agriculture fear-mongering, saying we have to keep up with this current production model.

The current production model is broken. It doesn't work. It's one of just treating symptoms—input after input after input. I realize the past three or four years have been very profitable, even under the current industrial agriculture model, but we can have sustained profits where we have diversity. Then we can start producing more nutrient-dense foods that are going to take care of the health crisis that is occurring in this country.

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