Holistic regeneration of our lands: a Producer's perspective.

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Transcribed by Dr. Stephanie Seneff from the video on YouTube at this link.

https://www.youtube.com/watch?v=9yPjoh9YJMkI

Today I'm going to talk to you about my five key points of building a healthy soil.

The first is the least amount of mechanical disturbance possible. I'm doing that in a no-till situation. I realize that organic producers are going to till some. Just make your tillage minimal.

This slide really illustrates the destruction of tillage.

This farmer had a forested area. He cleared part of that area and farmed it with intensive tillage monoculture soybeans for 17 years. And look what happened! That's a picture of the forested area soils and beside it, soil from the field that he cleared. What you see is a decrease in organic matter from 4.3% down to 1.6% with 17 years of tillage.

I wish I'd had the foresight back in 1991, when I bought that place, to archive some of the soils, because I guarantee that they look like the soils on the right there. They were compacted, there was no life in them, and as I said there was less than 2% organic matter. We had taken the life out of those soils.

No-till is a big part of that, and no-till will work anywhere in the world where there's production agriculture. I've seen it. It works, and it's key to building healthy soil.

The other thing that's key is to take advantage of the natural things that occur in healthy soils, untilled soils. And one of those is mycorrhizal fungi. I'm not a scientist so I'm not going to get real in-depth with that. But we don't take advantage of the natural processes that occur in our soil. Mycorrhizal fungi will form a symbiotic relationship with the root.

What it's doing is extending the system — the root network of that plant. So that plant is able to gather and store nutrients and water from a much bigger area.

But when we till, we destroy this. If we have untilled soils and promote healthy soils, we're going to have more mycorrhizal fungi. We're going to be able to take advantage of that. I'll show you some pictures of just how important that is.

One other thing mycorrhizal fungi can do when it gets into that host plant's roots: it'll prevent pathogens and nematodes from entering that root's cell wall.

So we can actually decrease the amount of fungicides, etc. that we have to put on crops because we're taking advantage of this natural ecosystem process.

Another thing that mycorrhizal fungi does: It starts soil formation. Think back to that picture I showed there with the 17 years of tillage and soybeans.

There are no soil aggregates in that picture. The soil aggregates are being destroyed. Mycorrhyizal fungi secretes a glue called glomalin. This is a sticky substance which starts soil formation. The picture on the left: Those are soil particles being formed due to the glomalin created by mycorrhizal fungi.

Here's what some of our soils look like today, after 21 years of no-till and everything else I'm going to talk to you about today. But notice that soil aggregation. That's what we want soils to look like. Soil should look like black cottage cheese. Full of carbon, full of pore spaces and that aggregation.

Mycorrhizal fungi do a lot of things. They improve aggregate stability. They build soil carbon. They improve water use efficiency, and they increase the efficiency of nitrogen, phosphorus and sulfur. And if we're adding certain fertilizers, especially phosphorus, to our farming practices — that's actually detrimental to Mycorrhizal fungi.

Ways to increase our mycorrhizal fungi? Reduce or eliminate chemical use. Reduce or eliminate tillage. Reduce or eliminate synthetic fertilizers. And plan to have a living plant root in the ground as long as possible through the year.

These are things we can accomplish both in our perennial systems and in our annual cropping systems. It can be done and I'm going to show you how we've done that.

In 2003 I was fortunate to meet Dr. Kris Nichols. She did some of the original work when glomalin was discovered by Dr. Sarah Wright. Nichols was a grad student under Dr. Wright.

Dr. Nichols came to the ARS lab in Mandan, North Dakota. In 2003, she came up to my place; looked at what I was doing. She said “Gabe, you've come a long way but your soils will never be sustainable unless you remove your synthetic fertilizer inputs.”

And I thought: wow! How can I farm without synthetic fertilizer? So, for the next four years we did split trials on our operation. In half a field we'd use synthetic fertilizer, and in the other half we wouldn't. All four years the non-fertilizer tracts of the field were equal or greater in yield than the fertilized tracts.

So we haven't used any synthetic fertilizer on our farms since 2008. How has that affected our yield? Our yields are 20% higher than the average. Am I the highest in the county? No! Am I the most profitable? Yes! Simple as that. But you have to get your soils healthy first.

And I'm in no way standing here to tell you to immediately eliminate synthetic fertilizer. You're going to have a disaster if you do. It's like a drug addict: You need to wean it off slowly. But once you build that population of soil biology, build that healthy mycorrhizal fungi population, you will be able to drastically reduce your synthetic fertilizer inputs.

The second principle of a healthy soil is armor on the soil surface. Look at perennial native grains. The soil is always covered. Bare soil is a detriment to soil health. I think back to my father-in-law telling me the more you work the soil the better it is. That is not the way nature works. Where in nature do you find bare soil? Only where there was a catastrophic event, or where man imposed his will on it.

This is what happens when we till. This is eastern Colorado this past January. You'd think it was back out of the 30's and out of the dust bowl. Not so. You would have thought we would have learned something in the past 80-plus years. Evidently we haven't.

Last Father's Day my son said, "Dad, for Father's day I'm going to take you on a soil health tour." This is what we took a picture of on that soil health tour. It was an operation with tillage. I don't see much soil health in that photo.

This is what it looks like on *our* operation. That's a seeded field. We want armor on the soil surface. We want that soil covered at all times.

Here's a cover crop emerging through that armor on the surface. How are weeds going to germinate there? I'm able to save on herbicides because we have that armor. Weeds aren't going to germinate through that. But the crop does just fine.

That residue also buffers heat. Now, we can get hot at my ranch. Not as hot as it gets in Southern Idaho. But we can get pretty hot in August. That heat is detrimental to soil health. Here we had a tour out on our place and we stuck this thermometer in the soil — the photo on the left. That's where the cover crop is. It was almost 100 degrees that day. But the soil thermometer registered 87.6 degrees under the cover crop. On bare soil, the soil temperature was 107 degrees. That 20-degree temperature difference is huge.

What's the effect of temperature on soil life — for our plant growth? At a 70-degree soil temperature, 100% of the moisture is used for growth. Once we get to 100 degrees, only 15% of that is used for plant growth.

In other words if I don't have armor on my soil surface, my plants aren't going to produce. They're not going to grow any more. But Where I have armor I'm still getting growth out of my plants. That equates to dollars in my pocket. If we get much hotter than that, we start affecting soil biology, and soil biology is the key driver for the nutrient cycle that's going to provide our plants with nutrients.

We need to keep those soil temperatures down. The other thing is you have armor on the soil surface and you'll have a lot of biology. There are more microorganisms in a teaspoon full of healthy soil than there are people on this world. Think about that.

Yet, how often do we think about feeding that soil biology? How often do we think about protecting, keeping armor on the soil surface? We need to do that.

This photo shows cover crop residue brushed away from some soil. I know it's hard to see here, but that's solid earthworms in the soil. When we bought that farm in 1991 I tell people I could never take a day off to go fishing because you couldn't find an earthworm on the whole farm.

Last Spring we did earthworm counts. In 12 linear inches, we averaged over 60 earthworms. That's a lot of earthworms. I never transplanted any. I didn't bring any in, they came in on their own. Build it and they will come. But you have to provide a home for them first.

Third principle of building a healthy soil is diversity. Look at true native range land. This photo here is from one of our native range land pastures.

I tell people I bought that land for two reasons. Number one, because it was true healthy native range which hadn't been disturbed.

My son teaches ranger management at the local community college. He brought his class out to this particular paddock. And in two hours, They counted over 140 species of grasses. That's diversity! If we have that type of diversity in a healthy native range, why don't we have it on our crop land?

The other reason I bought this pasture is simply because, with that many rocks, I'd never be tempted to break it up.

In 2006 I had the opportunity to speak at a conference and this gentleman was there: Dr. Ademir Calegari from Brazil. Dr. Calegary is the world's foremost authority on cover crops.

Note: Link to related article in the website www.grazeonline.com

http://www.grazeonline.com/plantdiversit

Dr. Calegary works for the United Nations; travels all over the world. He's worked in 65 different countries. And he said two things at that conference that really stuck out. He said you give me two inches of rainfall a year, or 200 inches, or anywhere in between and I can grow you a cover crop. Well, that told me I can do it in my drier environment.

The other thing he said was, Cover crops are meant to be seeded in multispecies combinations. And I got to thinking, *duh*, I've been using these two and three way mixes Dr. Calegari was talking about 7 and 8 and 10 way mixes.

Think back to those native ecosystems. What do you find? You find tremendous diversity. I needed to get that into my cropland. So at that time, I was on the local soil conservation board, and we had some cropland located only a mile south of my farm.

And we decided to test Dr. Calegari's wisdom there. We were going to take seed monoculture cover crops, strips of them, and then at the end we'd mix all these species together and we'd seed a diverse polyculture, and see what happens.

Now, that winter was extremely dry in North Dakota. We didn't have a lot of snow. So we seeded these monocultures and these polycultures into very dry seedbed in the middle of May.

These photos were taken July 31. Here's the plot with the cover crop growing. We had less than an inch of rain on these crops. Plots were about an acre each.

Then you move over to the next acre — that was the radish. That was dried up and dead. You keep going down the line until you get to the diverse polycrops. Same soil, same seeding rate,

everything was the same. But look at the difference! Amazing, and that was about a 10-species mix. We more than tripled dry matter forage production where we had the multispecies combination.

So, what's happening? How can that be? For all our lives we've been told that you have to seed these monocultures. Otherwise it's going to compete for moisture. That's not the way nature works.

Dr. Nichols explained it best. Mycorrhizal fungi not only provide for the needs of one plant, but the mycorrhizal fungi variations apply to multiple plants, thus supplying the nutrition and moisture requirements of all the plants.

So, in other words, if we seed multiple species of plants, then multiple kinds of mycorrhizal fungi will transfer nutrients and benefit all the plant species.

Think of it this way: Roots on different plants have different root heights, different root depths. They're bringing in nutrients and moisture from different areas of the soil profile.

I've spent a lot of my time talking in the Midwest, and this is what I see in the Midwest: Monoculture of corn. Monoculture of beans.

What happens to soils under monocultures? Remember this photo. Monocultures are a detriment to soil health. There is no doubt about it. If they weren't, then why in nature don't we find monocultures? So this is what it's evolved to. I didn't get to this point overnight, It took a lot of years of trial and error.

My son and I have a few sayings on our operation, and one of them is we want to fail every year. If we don't fail we're not trying enough new things. So, I tried a hundred different combinations over the years but we've gotten to the point where we no longer seed monocultures.

In the upper left there, that's oats with clover growing in it. Cool season grass. Upper right, that's a mix of the lower left; corn with hairy vetch in it. Warm season grass along with a cool season legume. And in the lower right that's actually sunflowers, warm season broadleaf, with over 20 species of cover crops growing with it. We're trying to mimic nature.

We don't do monocultures any more on our operation. I mentioned we have 2,000 acres of cropland on our operation. We try and get a cover crop on all 2,000 acres every year. Either before a cash crop, or along with a cash crop, like this case, or occasionally after the cash crop. *But we want something growing all the time.*

Here's a close-up picture of oats. We no longer use any synthetic fertilizers, as I mentioned. There's no need when you get a healthy soil. Nature will take care of those symptoms if you allow her to.

Here's what it looks like close up. We seeded three types of clover along with the oats. We can typically get our yields of oats in the 95 to 115 bushels. And if you're talking about our land values, that's pretty profitable. The beauty of it is, we've got that living cover, all those legumes provide grazing for our livestock if we so desire.

The fourth principle: Leave roots in the ground as long as possible. That's where cover crops come in. And I think of cover crops as a diverse mix that enhances the life and the function of the soil, because we're really feeding that soil microbiology.

You select and use cover crops to make up for what you don't have. There's a big cover crop craze going on throughout the country. And I've seen a lot of disasters with cover crops because people don't plan properly. What are you trying to accomplish with that cover crop?

Are you trying to increase organic matter? Are you trying to put armor on the soil surface? Are you trying to improve water infiltration?

And the list goes on and on. But before you start planting cover crops, you have to decide: What is it I'm trying to do? We have 2,000 acres of crop land. I honestly don't know how many fields. I haven't added them up. But, we design cover crop mixes specifically for each field, because the resource concern will usually vary from field to field.

So for instance, suppose you have the resource concern of a compaction layer. Then you're going to use cover crops such as this daikon radish. And if you look down in that soil profile, there was a compaction layer about 12 inches deep. It tried to grow, then when it hit that compaction layer it grew above ground until it gained enough energy to poke its way through below. Radishes are also a nitrogen storage tank, so we use them in combination with legumes to sequester and store nitrogen for the next crop then.

That's my fertilizer storage tank right there. These radishes can get really large. If you grow them, seed them a little later in the year. They can get really big. If you seed them in the spring they're going to bolt and produce a seed head and they won't produce that nice tuber.

This system that I'm talking to you about today can take place anywhere in the country. I've got producers all over the world that are using this model. Joel will talk about it later today too — ways to produce a healthy ecosystem. This picture is of David Brandt, a friend of mine near Columbus, Ohio.

This photo is from 2011: 225 bushels of corn. Zero synthetic inputs. Zero herbicides. Zero pesticides. Zero fungicides. David likes to brag about the big radishes he grows. He and I would always have a contest, so I brag about my turnips.

This is a partial list of the cover crops we grew on our ranch here this past year. Don't pay any attention to the species, because that's going to vary from area to area. But pay attention to what I've got here. I've got some species in all four crop types. Warm and cool season broadleaves and grasses. I'm using the cover crops to get diversity into my annual cropping system to build soil health. And that's what it's about. We're trying to address those resource concerns and build soil health.

So, I question the rationale of some things. My neighbor's not here today so I can talk about him. I've been on our farm since 1983. His farm is directly across the road from me. Every fall he goes out and tills this spot. *Every* year.

This is a photo taken June 16, 2009. I took it off of the front deck of my house. The local weather service was forecasting a major rainfall, which for us means anything over a half an inch. I took this photo. It started raining at 6:30 in the evening and by 12 midnight we had accumulated 13.2 inches.

This is a photo of the neighbor's tilled area, taken three weeks after that rain. It still had water sitting there. This happens every year.

This photo is my cropland directly across the road from his. Next day after that 13.6 inches of rain, we had four-tenths of an inches of rain. You see any erosion there? Now I've got a little bit of bare soil in the foreground here. When you get that much rain it's going to remove a little of that residue.

Jay Fear, our district conservationist, came out and took these photos. Here's a photo of that soil that day. The morning after 13.6 inches. Jay makes the claim: You could have driven a floater truck or any type of equipment over that field that day without ridging it up. Look at the soil aggregation. If you have those water infiltration pores you're going to take that water down and you're going to hold it in the soil profile for when you need it.

I mentioned when I started out in 1991 we could infiltrate a half-inch in an hour. In 2011, the last time NRCS came out and tested my soil for infiltration, we could infiltrate over 8 inches an hour. I've never seen it rain 8 inches an hour. It's not how much moisture you get. It's how healthy are your soils — can they infiltrate it and can they hold it and store it?

The fifth principle of building a healthy soil: animal impact. In 1971, this paper, the Prairie Farmer, depicted bison and wolves. The wolves are following the bison, keeping them moving.

How do soils form? Soils are formed in conjunction with herbivores. Why don't we have that in agriculture today?

We had these large herds of bison moving across the plains and we also had local animals — the rabbits, the grasshoppers. All these insects. They were taking this forage, the biomass, and cycling it through. Animals are an important part of a healthy ecosystem.

Today it's not uncommon to drive for thousands of miles and not even see a fence, let alone an animal. Why have we removed them from the ecosystem, and then we expect our soils to be healthy? Not gonna happen!

In 2007 I was speaking at a conference in Brandon, Manitoba. When I got done speaking, I had this guy in my face telling me, "Thatta boy! Wait until you see what *I'm* doing." That was Neil Dennis from up there in Canada. Neil is the mob grazer who puts huge numbers of livestock on an acre. I thought I was high stock density, running 200 to 300 pounds of livestock on an acre, until I met Neil.

That next spring I went up there and viewed his operation to see what he was doing. The thing that amazed me was that when we dug down in his soils he was building more topsoil quicker than I was. And that bothers me. Because I don't like to be second fiddle.

But the important thing was that I could take a lesson from Neil. And I knew immediately that Neil was doing this on perennial pastures and I understood that. But I needed to get more animal impact onto my cropland. That was the missing link in building soil health further on my cropland.

So this is our ranch today. This isn't quite all of it, but the light blue areas are cropland. The light green areas are tame grass pastures. In other words it was tilled at one time and now it's seeded back to perennials. And then the yellow area is our perennial pasture. I mentioned we had three pastures starting out. We now have over a hundred permanent pastures, but an infinite number of smaller ones. When we took over that operation, we could run 65 cow-calf pairs — it ranged from four to 800. Today we're running 350 cow-calf pairs, yearlings and grass-finished cattle plus some other livestock.

But what I want to show you is that we're able to integrate all of these — the perennial natives, the perennial grass. We integrate them all and graze livestock on all of them. Now, one of the easiest ways to get started into grazing animals on cropland is in fall seeding of biennials.

This photo was taken here in early October. We had just harvested a crop. Then we seeded a combination of winter hairy vetch, sweet clover and some radish in there. It's just poking through the ground there in October, even though we froze many, many times before that. So what we'll do then: We'll let that go, and then next spring we'll mob graze high stock densities on these high carbon annuals. And we build very small paddocks. This photo I'm just using for illustration was taken on some tame grass pasture. But we'll go out there and I don't care if you even have one animal, you can do high stock density grazing, just make your area small enough. That's all there is.

So we'll go out there in the morning and we'll roll up the previous day's paddocks. Setting up the new day's paddocks takes about an hour. These latches are solar-powered gate openers with timers; that's a bungee cord attached to it. We punch in the time we want each paddock to open, and then the livestock move themselves the rest of the day. We don't have to be there. So, when we're using this as a tool, and that's all mob grazing is — just like no-till is a tool. Cover crops are a tool. These are all tools. But we'll use that to address our resource concern.

And in this particular case where we're mob grazing these fall season biannuals, our resource concern is trying to get more armor on the soil surface. So we let that go, in order for that cover crop to get to a higher carbon state. Now obviously if we want a maximum gain on the livestock, we'd graze it when it's more immature. But we want the higher carbon state.

There the latch just opened, and in this particular photo, there's about 675,000 pounds of livestock weight per acre moving on until the next break.

And here is what we're left with when they're gone. That solid mat of carbon on the soil surface. The armor that's going to protect that soil. We only want the livestock to eat about a third of the above-ground biomass. What happened when the herds of bison were moving across that plains? Were they eating everything? No! They were trampling way more than they were eating.

But it's that biomass on the soil surface that causes nutrient cycling, preventing temperatures from rising, preventing wind erosion and doing all these healthy things that occur in a healthy ecosystem.

Then here's what we can do: This is a photo just three days later. Remember we were grazing this at a higher carbon state. It was already starting to form a seed head. So when we run those livestock on there, they trample it. It's going to die so I don't need a herbicide to kill it. Then I go in there immediately and seed again. Now, our window of growing season is not very long. I don't have time then to get a cash crop established, but I can certainly get another cover crop established in there, which is what we do. In this particular case, we're going in with a very diverse mix. It's a warm time of year so we're primarily going to use warm season species. sorghum, millet, sunflowers, soybeans — that kind of thing

I still add in some cool season species in case we get one of these cold fronts blowing through, which can happen. Then we'll have something that's able to cope with those temperatures.

But look what I'm doing with this amount of diversity. I'm really accelerating biological time. If I would seed these as monocultures, it would take me 20 years to accomplish what I am able to do in one year.

Here's the seed just poking up through the soil surface. Notice that aggregation there. I don't like this photo. There's too much bare soil but it does show how all these seeds — seeded together at the same depth — do just fine. They come up and grow just fine together.

We're optimizing solar energy collection with these diverse cover crops. If you have a monoculture growing out there, how many leaf sizes and shapes do you have? One. No matter what direction that sun is from this field, I'm going to be harvesting solar energy. And that's what it's about for us as producers. We want to capture that soil energy, sequester it as carbon, and start the nutrient cycle. Feed soil biology. So if we get any moisture at all, the cycle works. This photo was taken with about two inches of moisture on it. And we can get some really good growth. Remember, my soil temps are kept lower. I don't evaporate down as deep. My soils are much more efficient water-use wise than other soils.

Then we have a lot of options with that cover crop. We tend to grass finish things, so we can turn some animals onto that warm season cover crop and grass finish. When we do that we do not run near as high a stock density because we're shooting for maximum gain. We want those livestock gaining two and a half pounds a day, and they'll do it on these warm season mixes. Or we can let it go and it will continue to sequester carbon and to build biomass. And that's what it looks like after a frost.

Remember: Extend the growing season. I used to think that our average last frost is in mid May. First Fall frost comes in early September. I once thought that narrow window was my growing season.

The biology in the soil keeps the soil warmer, so we can easily grow species up until Thanksgiving most years. Now this year with the cold we've had, we're probably done for the year.

Here's how we convert most of our cover crop to dollars. we used to calve in February and March, which is the reason I have no hair. Because it just doesn't work in North Dakota. We now calve in late May and June. We leave the cows out there all winter. The beauty of these cover crops is you can add so many species and you can balance their rations. This cow here is eating hairy vetch. Hairy vetch in December will still be 18% pure protein.

Their nutritional needs are met by the cover crop. Why in the world would I want to put up hay, spend dollars? We have a motto on our operation: We want to sign the back of the check, and not the front. It's a pretty good motto. It leaves a lot more in your pocket. It works good. It's a lot of fun too. It allows me to come to Idaho when I could be home working, feeding hay.

I'll tell you a little story. This fall we met a father and son who had heard about our operation. They traveled up for a tour. And they were explaining their operation to me. They ran 1,000 cow-calf pairs and they backgrounded the calves. They told us: "We've got two hay machines, we put up hay. We have three balers, and two semis to haul all that hay home. Then in the winter we start four tractors every day to feed those thousand cows and their calves."

They turned to my son and asked him, "What's your day like in the winter?"

He said, "Well, I usually get up and make some coffee. Then I sit in the recliner and watch TV. My biggest problem is I wear out the recliner."

Last year we wintered 350 cow-calf pairs and we only started our tractor once. Animals have four legs for a reason: We don't need to provide them with a bed and breakfast. Let 'em find it on their own. They prefer doing that. I honestly believe they're happier doing that. When we start confining animals, we start causing more problems.

And they can do it when it's real cold. That's not musk-ox. That's 350 cow-calf pairs grazing cover crops at over 40 degrees below zero. I actually felt sorry for my son as I sat in the pick-up and he walked up and took this picture. But you know they're doing just fine and they're surviving just fine.

Part of the problem is, you got to make sure you have the type of cattle that can withstand those conditions. But we do that by letting nature make the selection. It's what we're able to do when livestock trample all that residue onto the soil surface. We don't want those livestock to eat all of that. We want to trample residue so we can build top soil.

See where the blue lines are in this photo? That's the residue, the cover crop we trampled three years later. That's about three inches of new topsoil that we're building. I'm not going to call it all topsoil. It's biomass; also it's organic material laid down on top.

We're able to accelerate soil formation by using the principles of nature. Here's what I like to say: One-third of the critters in a field are above ground, two-thirds are below ground.

Here's what it looks like in the spring after we grazed one of these cover crops. We have that armor on the soil surface protecting the soil.

I'm going to show you the fallacy of the current production model now. This particular field here we went and took standard N P and K tests. I know that's too small to read, but in the

upper left it says pounds of nitrogen in the top two feet of soil profile is ten pounds. How many bushels of corn crop can you get out of ten pounds of N? Not much, I heard. I'll show you how much I can do on ten units of N.

When I say I'm a no-tiller, I'm a no-tiller. Don't use roll markers — too much tillage. We don't want to disturb that armor. We want that protection there. I plant corn about May 15th. Here's June sixteenth. July first, where's the residue? I'm not out there cultivating, I'll tell you that. Where's the residue going? Here's a photo of that same corn crop at tassling time.

Dr. Ray Ward at Nebraska: He and I are friends. He used to think what I was doing was a bunch of hogwash. He came up himself then and took this soil test. Every single nutrient he tested was sufficient or above. We don't use foliars. No amendments of any kind; certainly no synthetics. So I went from that soil test to a leaf tissue analysis that shows everything supplied that the plant needs. Where does it come from? There's what that field looked like in the fall then. All that residue is gone. It's consumed by soil life. I'm embarrassed by this photo. That's bare soil. That's why I grow hairy vetch and other clovers with my corn now.

I don't ever want anyone seeing bare soil on my operation. I'm certainly going to try my hardest to prevent it from happening. There's what we did. Our county average is just under 100 bushels. We got 142 bushels of corn crop without adding any — *no* — fertilizers, *no* pesticides, *no* fungicides, *no* herbicides. My cost to produce a bushel of corn, market it, everything is $1.44 a bushel. At today's corn price, I can still make money.

We don't take part in government programs anymore. No crop insurance. I don't want to be encumbered by that and I don't want to be on government welfare.

We can produce more at a lower cost in this type of production model. There's no doubt about it. The soil is alive if our management allows it to be. We have to look at healthy ecosystems, and look at what the soil needs instead of what the plant needs. Soil without biology is just geology.

The reason that soil tests didn't work is that they only take into account the chemical and physical properties of the soil. It did not take into account all the biology that I have in my healthy soil.

This gentleman here, Dr. Richard Haney at Temple, Texas, has developed a new soil test that I think will really help link the conventional production model into the more biological production model. You send a soil test in there and Dr. Haney is measuring things like water extractable organic carbon, which is what the biology needs.

He's able to extrapolate and determine how many nutrients you get out of your soil due to the biology, the chemical and the physical properties. This new soil test will revolutionize soil testing in North America. There's no doubt in my mind it's being used now — there are six labs doing this soil test. It's about $50 per test.

The impact of livestock on cropland will be the link which will show producers how much they can cut back on their synthetics, if they are using synthetics.

For years I was told, “Gabe, your system's going to crash, you're going to run out of nitrogen and phosphorus.”

Well, nitrogen is a no-brainer. Above every acre of land we have about 34,000 tons of atmospheric nitrogen. I don't know why anyone would write a check for nitrogen when it's free. All you got to do is plant legumes. It just makes no sense to me. That's nitrogen; we're not going to pay much attention to that.

This is comparing two of my fields. They have both been no-tilled for a long time. Both have had very diverse crop rotations. The only difference is the green barred field has had livestock integration for 2-1/2 years. Nitrogen is about the same there; 86 to 90 pounds. The second bar there is inorganic phosphorus — in other words, what's available to the plant. We jump from 69 pounds to 239 pounds. Now how did that happen? Those livestock didn't bring any phosphorus with them. But what this shows is the importance of herbivores grazing on the land.

Because they're grazing a living crop, that crop is able to secrete more root exudates, which breaks down more of that organic phosphorus, so it can cycle through to the plants. Nature had this all figured out for thousands of years. It's just that we forgot about it with our stupid industrial farming.

We need to get back to the principles of nature. The third bar there is potassium. Same thing: significant increase. When we start following the principles of nature, nature takes care of all of this. It's so much more fun not having to write a check for this stuff now.

Now I'm not going to tell you that there's not areas where there's blatant nutrient deficiencies. And you're not going to get this overnight. But I know one thing: There are thousands of producers using this model all over the world. We've had visitors to our operation from all 50 states and 16 foreign countries.

I've had groups from South Africa, and England and Denmark and Australia. We're all doing the same thing. I haven't found anywhere in the world where there's production agriculture where this model won't work. It's simply the model that nature provided.

My son took this photo a few years back and I just love it. That's us in the foreground our neighbor in the background. Which is going to put more dollars in your pocket?

Here's a young man who first heard Ray and me speak four years ago. Michael Thompson down in Kansas. His dad was pretty hesitant. He said, “Well, Michael I'll tell you this much. I'll farm half of it my way. You farm half of it your way.

This is after four years. Look at the difference in their soils. That's Michael's side of a field on the left. That's his father's half of the field on the right. Which one has more carbon? Which one has higher organic matter? Which one has more soil life? Which one has more aggregation? More infiltration? That's an amazing photo. We can change soils in a very short time with diversity animal impact. It works. We've seen a real upward trend in organic matter on our operation.

I mentioned our soils were less than 2% organic matter when we started. We are 5.3 to 6.1% now. And this has taken me a lot of years to learn all these things. I'm a slow learner but guys like Michael, who try things a lot faster than I did, are going to make even more rapid advances.

Now what's the value of that? Take a look at organic matter levels, then you can start extrapolating the amount of nitrogen, potassium, sulfur in your soil. One percent organic matter soil has about $751 per acre of those nutrients in it. My 5% organic matter soils has over $3,700 of nutrients in there. Back when I used to have to use a banker, I went to him and I said I want to put that on my balance sheet. He said, well I can't do that. I said, Why not? You allow Joe to prepay fertilizer and put it on there. He said you got a point. Now I no longer use a banker, and it's a lot more fun.

Now, in your dry environment here I'm going to run through this little analogy on the importance of water-holding capacity of soils. The middle column shows my soils when I started: Less than 2% organic matter. I could only hold 2 inches of moisture per foot of soil profile, for a total of less than 8 inches of water. Today I'm well over 5% organic matter. I can hold over 20 inches of water in the soil profile. We only get 15 inches of rain on the average per year. I can hold all the moisture that falls on our operation.

It's not how much moisture you get. It's how much you save and use. Two weeks ago I was in southeastern Missouri in the delta region. They get over 50 inches of annual precipitation. And they're applying 50 inches plus of irrigated water to produce 200 bushels of corn.

Well I put together a slide showing my yields. I'm producing just under nine and a half bushels of corn per inch of water. They were producing barely two bushels per inch. I said: If you had my water efficiency you'd be producing 950 bushel of corn.

Right? Very inefficient system they have. It doesn't make sense. They cannot compete, production wise, with what we can do with healthy soil.

Okay, so, for 1% organic matter and the top six inches of the soil profile, you'll hold about 27,000 gallons of water. So, in 1993 when I started our 5,000-acre ranch we could hold 256,500,000 gallons of water That sounds like a lot, but today we can hold over 810 million gallons of water. That's huge; think of the ramifications.

There’s a reservoir near you. It'll hold about 1,250,950,000 gallons of water.

At the rate we're improving organic matter on our farm, we're going to be over 10% pretty soon. In other words our 5,000 acre ranch will hold more water than that reservoir. That's the potential each of you as producers have. I don't care what scale you're talking about or whether you're talking a large ranch. The water-holding capacity is up to you. Don't blame it on drought or how much rainfall. We all have the ability to change our soils.

Soil carbon then is the key driver for the nutritional status of plants. It is the key driver for moisture holding capacity. In other words, soil carbon is the key driver for farm profit.

Any farm you go on, that's going to be the key driver for farm profit. All living things are based on carbon. We have to start thinking about our operations in terms of carbon. I'm going to

show you now — if you don't think I'm crazy by now — I'm going to prove it to you. Me and Gabe Ford down there in Kansas; we have a contest every year. Who can do the craziest thing? I got thinking about cover crops, and I got to thinking about my garden.

I had some potato growers there, and they said Gabe, it's all well and good what you're doing. We're potato growers; we can't do no-till. So I thought about that through one winter. So this is my no-till potatoes. We lay down a little layer of compost. We just lay it on top. We fire up the tractor and roll a round bale of alfalfa hay over the rows of potatoes.

Peel back the alfalfa hay, and there's our potatoes. We can do it no-till. It's easy. It works good. Potatoes aren't going to be quite as large, but it's sure a lot easier to grow potatoes this way.

For the garden, we just took 30 species of annual vegetables, 20 species of annual flowers, mixed them all together, put them in the ground, and that's our garden.

The wife would ask me: "What do you want for supper?" Whatever we tripped over in the middle that's what we harvested.

We're dry land. Don't have any water. But we don't have to, because we're taking advantage of the biology in the soil and the natural ecosystem in the soil. The mycorrhizal fungi moving those nutrients and that water. Works fantastic. We took all we wanted and donated the rest to needy families and it's a good project. We ran the grass-finished beef on there. We ran the poultry on there. Works extremely well. We're stacking enterprises.

Vandana Shiva said this: In nature's economy the currency is not money; it is life. So think what I was doing when I had these 70 species mixed. I'm adding as much life. I had as much biological impact on those soils in one year as I would have had in 70 years with the conventional approach.

We're accelerating biological time; that's all we're doing. On our operation then it's about feeding the whole. We want to feed everything. We don't look at everything as independent. One of the tings we do is we pay a lot of attention to insects. On all the cover crops and annual crops we grow, we want species flowering at all times, because they're going to attract both the pollinator insects and the predator insects. I mentioned I haven't used a pesticide since before the turn of the century. There's no need because we give a home to all the predator insects. They're going to take care of all the pests.

Here's a good friend of mine, Dr. Jonathan Lundgren. He's an entomologist at ARS in Brookings in South Dakota. He told me this: For every one insect species that's a pest, there are 1,700 that are either beneficial or indifferent. So as producers, we're focused on killing that one pest. Meanwhile we're killing everything else that could take care of that one. Makes absolutely no sense. Sign the back of the check, not the front.

We also have to focus on the life in the soil. All that biology that's in the soil, because that's what drives nutrient cycling.

We also have a tremendous amount of wildlife on our operation. We're located now within a city jurisdiction. The city of Bismarck is one of the fastest metropolitan growth areas in the United States. We have a huge wildlife population on our ranch. The wildlife knows where they have a healthy home.

Now I'm not going to get into livestock very much today. I'm going to speed through this on account of time. But on our operation we run 350 cow-calf pairs, we have 400 to 800 stocker cattle along with grass-finished beef.

We also have a ewe flock and we're raising grass-finished lambs. We run these together to try to mimic the native ecosystem — what it once was. There's no longer bison where we are; my neighbors would get upset if there were bison drinking out of their swimming pools. So I have to mimic this however I can.

So we have cattle, we have sheep, we have broilers. Now we're limited a little bit. There's no slaughter facility in Northern South Dakota. So they limit us to 999 broilers which is about as many as my son can talk his dad into helping him butcher.

We run those broilers out on these cover crops. Works extremely well. I laugh today when I hear people talking about the high price of calves. They're getting $3 to $3.50 a pound for calves. My son gets $5 a pound for broilers. That is the most profitable enterprise on our operation right now. He also has layers.

This is Paul's version of Joe's egg-mobile. Paul takes these old stock trailers, tears the floor out of them, and we pull them around where we have the grass-finished animals. They take care of the fly problems. They spread that cattle manure out, works fantastic. It's taking advantage of what would occur in a natural ecosystem.

We also have pastured pork. We raise the pigs and sell pastured pork. We produce a lot of grain. We prefer to market it through the hogs, a little bit through the chickens. Most of our grain gets sold to other producers who want to buy healthy grains. We've been non-GMO now for six or seven years; something like that.

We're not certified organic simply because I don't feel I should have to pay somebody for what I already know. Our ranch is open to tour customers at any time. They can come any time they want and see what we're doing.

What we're trying to do with all these species is to harvest different levels of energy. Pete made a point about feeding 9 billion people by 2050. In this type of production model there is absolutely no problem with that. I'm producing cash grains and I've got all these different other enterprises on top of that. I will produce way more calories per acre than any standard of monocultures.

Feeding the world is no problem if we change our mindset. What we're doing on our operation is we're stacking all these enterprises. There's an infinite number of possibilities out there and I know Joe will talk a lot more about that. I could care less what happens to the price of individual commodities.

Those boys are tied into the price of corn and beef. If you're tied into a system that has multiple enterprises, doesn't matter. We're always going to have something that's profitable.

We as producers must also remember that we are in the business of producing nutrition. Our decisions greatly affect human health. You know the United States spends more on health care than any other country in the world, yet we're the 42nd healthiest country in the world. We're first in cancer, ADHD, Alzheimer's, autoimmune diseases, obesity — and the list goes on and on.

Why is that? I'm not going to blame it all on producers, don't get me wrong. But we as producers have to take part of the blame for that. We have to start focusing on producing nutrition instead of just yield.

Here's a photo my son took. That's our pastured egg on the right, that's a conventional store one on the left. You're going to be amazed at the difference. That's one thing we're really focused on in our operation now: tying soil health into human health. We're starting to do a lot of nutrient testing of the products we're producing so we can back up that statement.

In North Dakota there were only three processing plants in the state. The waiting list to get an animal processed was over a year. So a group of us got together and we opened this meat processing facility in January. So now we have our own abattoir where we can process livestock. That way we can direct market. We're trying to direct market everything we produce.

That's our own trademark logo: *Nourish by Nature*. We're trying to provide nutrition to people through the natural ecosystems. Here's our meat trailer. We're direct marketing to consumers in Bismarck, North Dakota. We can't even begin to keep up with demand.

We never expected the demand onslaught that we received. There's nothing more gratifying than handing somebody a steak. They give you $20 a pound and they thank you for it. That's a good feeling you know; I can live with that.

Starting on the left in 1993 — we had shallow soils; 1 percent organic matter. We started the no-till. Then we started to diversify the cash crop rotation and noticed an uptake in our organic matter.

In 1997 we really started focusing on cover crops, another jump in soil health.

In 2006 we really started planting the multi-species cover crops. Then we started adding mob grazing and integrating all these different livestock species on the land.

With each one of those things we did, we saw a marked improvement in the health of our land, health of the ecosystem, and in water holding capacity.

By 2013 we had a plot of land that had risen to 11.1 % organic matter using these principles. We can improve soil health much, much faster than we thought possible.

If you have healthy soil you're going to have clean air, healthy plants, healthy animals and healthy people. And that's what it's about on our operation. How do we produce a healthy ecosystem and equate it to healthy humans?

So with that here's my contact information. Feel free to contact me or my son at any time. We'd be happy to visit with you.

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