Building Better Soil with Cover Crops

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I never miss an opportunity to have something growing on my land. Green plants feed soil life, build organic matter, and capture nutrients in their tissues. Keeping my nutrients in a biological cycle means those nutrients will not leach or erode, and they are in a form that is linked to biology so it is easier for plants to access them. Nutrients held in a cover crop do not show up on a soil test, but as those plants break down, the nutrients in them are released into the soil in a plant-available form. When I do not have a forage crop or row crop growing on my land, I want to have a cover crop growing. A good cover crop can provide many benefits, including:

- Improving water infiltration into the soil
- Reducing water loss from bare soil by evaporation
- Holding soil in place and reducing erosion from wind and rain
- Reducing fertilizer inputs by providing calcium, phosphorus, potassium, nitrogen and micronutrients to the following crop
- Breaking up soil compaction
- Producing compounds that deter weeds and crop pests
- Increasing soil organic matter levels
- Feeding soil biology

There are many different types of cover crops, and each provides different benefits, but there are a couple of things that all cover crops have in common: cover crops increase plant diversity in your rotation, and they pull up and hold onto soil nutrients.

COVER CROP VS. GREEN MANURE CROP

I often use the terms "cover crop" and "green manure crop" interchangeably, but they are not always the same thing. A green manure crop is a type of cover crop, but not all cover crops are green manure crops.

There are four main types of cover crops: 1) those planted to build soil fertility and organic matter, and improve soil tilth — the "green manure" crops; 2) those planted to break up soil compaction; 3) those planted to manage weeds or pests; and 4) those planted to hold soil in place, improve water infiltration, and prevent erosion. Of course, no cover crop does just one thing. They all provide multiple benefits. That is one reason why I will use the term "cover crop" to describe these plants, regardless of their individual benefits.

Freshly Rotovated soil-building cover crop.

THE BENEFITS OF PLANT DIVERSITY

There is a lot to be gained by adding more types of plants to your rotation through growing cover crops. Many pests, for example, prey on a relatively narrow range of species, so increasing diversity can break pest and disease cycles. Growing a wide range of plant species can also increase microbe diversity because different microbes prefer different types of plants. Another benefit of increasing plant diversity is that different types of plants access nutrients other than those the crop will pull up, so planting cover crops and working them into the soil can increase the amount and variety of plant-available nutrients. Finally, cover crops can have a different type of root system from the main crop, which will help keep channels in the soil open to allow water infiltration and air movement.

I run a lot of different test plots on my farm, and when I was first starting out I wanted to demonstrate the value of planting a diversity of plants by establishing a continuous corn plot on my farm. This sounds counterintuitive, but what made this corn-on-corn field different was that it always had one or more cover crops on it.

A lot of farmers have learned from experience that problems with diseases and pests occur when you grow corn-on-corn and don't rotate your crops. By interseeding my corn crop with clover and planting rye each fall, I wanted to show farmers that you do not have to rotate your crops to get diversity in the system — you can get diversity by adding cover crops. Planting clover and rye with my corn meant I was growing not one crop, but three. In addition, not using herbicides gave me more plant diversity in the form of weeds. Having weeds on my fields is not all bad, as long as I use management techniques like early cultivation to keep them under control.

After ten years of planting this corn/cover crop system on the same field, a University of Illinois researcher visited my farm and took a look at the field. He was very surprised by the health of the

plants and the lack of crop pests. He had never seen a 10-year continuous corn field without corn rootworms in it. He could not understand how I was able to maintain such a healthy cornfield without rotating the crop. Of course, it was not really a 10-year continuous corn field, it was a corn/clover/rye field. The diversity added by the cover crops helped break pest cycles, kept the nutrients cycling, fed soil life, and improved soil structure. By adding cover crops, corn-on-corn really can be a sustainable farming system.

Increasing plant diversity results in a wider variety of soil life and insects, and as a result no one disease or crop pest can take over. If you are planting a corn/beans rotation with no variation and no cover crops, you have neither a diversity of residues nor soil life, and as a result you will not be able to stop the diseases and insects. That is one reason there are so many bioengineered crops and such heavy pesticide use: we have removed diversity from our farming system, and as a result we are in a constant battle against insects and diseases.

Plant diversity is the key that can break those pest and disease cycles. Since each type of plant uses different minerals, cover crops put different minerals back in the ground as they break down and this feeds a variety of soil life, improving the entire biological system. This means that the more plant diversity I have, the more success I have on my farm.

Nutrients Present in Otter Creek Organic Farm Green Manure Crop

N	92 lbs./acre
P*	16 lbs./acre
K*	78 lbs./acre
Mg	16.5 lbs./acre
Ca	37 lbs./acre
S	8 lbs./acre
Trace Minerals	9.5 lbs./acre of Zn, Mn, Fe, Cu, B

**Value converted to P_2O_5 and K_2O*

COVER CROP NUTRIENTS

Cover crops help make nutrients more accessible to your crop by pulling them out of the soil and holding them in their tissues. When the cover crop is worked back into the soil, microorganisms digest the plant material. As those bacteria, fungi, and other soil creatures die and decay, or are consumed by other soil organisms, they release nutrients into the soil in a plant-available form. They also produce proteins and increase plant-available nitrogen through their own biological processes. This means that as a cover crop breaks down in the soil, there is an increase in soil biological activity and a release of plant-available nutrients for the next crop growing on the land.

I wanted to demonstrate just how many nutrients are held in a cover crop, so several years ago I grew a cover crop and tested the plants. In early August, I planted a blend of Italian ryegrass, hairy vetch and buckwheat. Two months later, just before the first killing frost that fall, I tested stems, leaves and roots to determine what nutrients the cover crop had extracted. Based on my calculation of the number of pounds of biomass per acre produced by both the aboveground and belowground portions of the cover crop, the table (at left) shows how many nutrients per acre were held in those plants.

As you can see, the cover crop pulled a lot of nutrients out of the soil and fixed some nitrogen from the air. Those nutrients will be held in the dead plant tissues and roots over the winter, and in the spring when microorganisms break down the tissues, most of those nutrients will be released back into the soil. In addition, the vetch and ryegrass will grow back in the spring and pull even more nutrients out of the soil. After I work the cover crop into the ground in the spring, those nutrients, along with carbon the plant fixed through photosynthesis, will

Working Cover Crops Into the Soil

I recommend working spring cover crops into the soil with a rotovator when the plants are young, green and succulent. If you let the plants get too large or mature, they will not provide as many nutrients to the following crop. More mature plants are slower to break down, which means it takes longer for the nutrients to be released into the soil. More mature plants can also be harder to kill with a rotovator.

I think you have greater success when you shallow-incorporate your cover crop, but you can also burn down your cover crop with herbicides. Though it is not my preferred method, the benefits are still greater than the costs.

After the cover crop is worked into the soil, it is generally a good idea to wait five to seven days before planting, if soil and weather conditions allow it. If you need to plant soon after you incorporate or burn down your cover crop, be prepared to plant into heavy residues. In those cases where I need to plant into residues, I use row cleaners or a notched disc blade on my planter to make a clean seed bed where the seeds are in contact with the soil, not decaying residues. It is very important to get good soil-to-seed contact for uniform emergence and crop stand.

become food for microbes and then will be released into the soil.

Not all plants pull the same nutrients out of the soil. Different types of plants take up varying amounts and types of nutrients. Corn and potatoes, for example, tend to need a lot of available minerals in the soil in order to get the nutrients they need. Small grains, on the other hand, can grow on low fertility soils. Oats and buckwheat in particular can grow and produce a crop on poor soils where other plants would struggle.

A researcher in North Dakota did a study looking at how well buckwheat is able to pull nutrients out of the soil. He planted buckwheat in the summer and when the plants were mature, he worked them into the soil. Several months later, the researcher went back and took soil tests from the buckwheat field and found that soil phosphorus and magnesium levels were higher even though neither of these minerals had been applied to that land. How is that possible? The soil has a reserve of nutrients that don't show up on the soil test — close to 5,000 pounds of phosphorus and 10,000 pounds of magnesium per acre — and the buckwheat plant was able to access some of them. The roots of buckwheat plants produce a mild acid that breaks down minerals that are very difficult for other plants to access, like those found in the soil reserve, or in mined materials like rock phosphate. And it is not just the major minerals that buckwheat pulls up: it can also access some types of micronutrients that we don't usually look for on a soil test. In addition, buckwheat has a shallow, dense root system that pulls in a lot of minerals and holds them until the buckwheat plant breaks down and releases those minerals back into the soil in a plant-available form.

As long as a cover crop is standing, it is holding on to nutrients. If I planted buckwheat and then went out and took a soil sample when the plants were knee high, I would not see a change on my soil test. At that point the minerals the buckwheat pulled up from the soil are still in the plant. It is not until that cover crop breaks down that the nutrients will be released in the soil. That is why a soil test is only one part of the picture — the minerals found in growing plants are the real report card of success in soil management.

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