

Unlock the secrets in the soil

DR CHRISTINE JONES, AMAZING CARBON

There is an extraordinary soil health revolution taking place in North America. This farmer-led movement is receiving increasing attention and support from the United States Department of Agriculture (USDA), particularly the Natural Resource Conservation Service (NRCS). NRCS publish an annual Soil Planner, with the running title 'Unlock the Secrets in the Soil'.¹



Jim Harbach (top), watches as Peter Donovan² conducts a water infiltration test in a multi-species cover including buckwheat, sunflower, cowpea, forage sorghum, forage collards, non-GMO soybeans, Persian clover, Graza fodder Radish, mung bean, Cataba vetch, subterranean clover and canola. The cover crop is on land that would normally be used for a cash crop.

Multi-species covers and companion crops are taking the U.S. by storm. Innovative farmers are experimenting with up to 70 plant species to see which combinations work best. Some U.S. farmers are setting aside up to 25% of their cash crop area for cover crops. They believe the benefits far outweigh the costs. It has been reported that two full seasons of a multi-species cover can perform 'miracles' in terms of soil health.

'The Benefits of Promoting Soil Health in Agriculture and Rural America' was the topic of recent hearing of the United States House of Representatives Subcommittee on Conservation, Energy and Forestry (Committee on Agriculture).

A farmer's perspective

Pennsylvania farmer Jim Harbach has been using multi-species cover crops with highly beneficial results. Jim's testimony to the Subcommittee:

'...I am very fortunate to have been part of agriculture for more than 40 years. I have witnessed the transition from conventionally plowed ground to no-till. Some of our fields have not been plowed for 40 years. We have seen first-hand the transformation of our soils, and the positive results when you farm in Nature's image.

In the last decade, with the addition of cover crops, and the belief that plants feed the soil, instead of soil feeding the plants, we have seen incredible results. Some examples include organic matter increases of one percent in 3 years, and steady state infiltration rates that average 4½ inches per hour [11.5 cm/hr].

I am not an organic farmer, although we no longer use insecticide or fungicides, and only a fraction of the herbicides and fertilizers that we once applied. I used to be part of the group of traditional thinking farmers.

Agriculture today is farming a degraded resource, and has accepted this as normal. Despite our best efforts, our soils have lost the ability to effectively absorb rainwater, are void of biological life, and are depleted of nutrients. Our soils are so degraded that we must rely on industrial inputs to keep our farmlands productive.

We now have a broken water cycle as a result of a broken carbon cycle. The loss of soil organic matter has contributed to carbon dioxide levels in the atmosphere because we have robbed the soil of its carbon. Soil organic matter has many functions, water infiltration, water-holding capacity, groundwater recharge, and its ability to cycle and store nitrogen, along with other nutrients.

...what we need is a mammoth soil health education campaign to teach farmers, Federal and State agencies, regulators, universities, children and the general public. Farmers need to understand how the soil functions before they will value it as a resource.'

You can read and listen to Jim's full testimony through references.^{2,3,4}

As well as diverse covers, it is becoming increasingly common to see cash crops grown with 'companions'. Peas with canola, sub-clover with wheat, soybean and/or vetch with corn, buckwheat and peas with potatoes. On Menoken Farm, North Dakota, a mix of hairy vetch, berseem clover, dill, canola, phacelia, flax, buckwheat, sub-cover, turnip, radish, field pea, soybean and cowpeas grown as a flowering understorey with sunflowers attracts predatory insects, bypassing the need for insecticide.

Australian farmers may say that's all very well for North America, but those crops won't grow here! At the time of European settlement much of the Victorian wheatbelt had a



ABOVE: At Criswell Farms a cover crop mix is rolled, and blades open up a space to immediately plant the next crop.
BELOW LEFT: USDA-NRCS soil scientist John Chibirka finds excellent infiltration rates (>4"/hr) and earthworm activity in the soil on Jim Harbach's Schrack Farms. Below right: Lucas Criswell shows how alterations to equipment enable planting and rolling at once.
PHOTOS COURTESY WILL BRINTON.⁵



groundcover of green plants during summer months—even in summers when it didn't rain. The higher water-holding capacity was the result of intact microbial communities providing better soil structure.

Over the last 200 years, soils have become degraded and lost much of their function. To reverse this trend, farmers could experiment by setting aside some of the usual cash crop area for multi-species covers—or try adding one or two companion species to cash crops. This only needs to be done on a small area to begin.

Carbon flow through plant microbial pathways is enhanced by above and below-ground diversity, resulting in better structured soils with higher water-holding capacity and improved nutrient dynamics. As soils improve it will be easier for plants to survive over summer.

Chief of NRCS, Jason Weller said to the Subcommittee:

'This approach to managing our soils as a living ecosystem is something that we are really excited about.

... for many years, our organization, many in our culture, have been focused on the physical and chemical properties of soil. ... We are increasingly becoming aware of what is actually happening in that ecosystem below the surface of the Earth, what is happening in the soils. And what we are learning is that the life in the soils is among the most verdant, abundant source of life, diversity of life on Earth.

... we have a massive challenge to grow food, we have less land to do it on, how are we going to do it?

... when you have bare soil, on the hot summer months, you can actually cook the microbes in the soil itself. You can actually kill the microbes. Bare soil also increases the drying out of the soils and the plants, creating plant stress.

... At the end of the day, in my view, cover crops are one of the best risk management tools we can offer a farmer from our quiver of conservation practices, but this is a great risk management tool. It helps not only maintain yield, but also protects farmers in periods of stress.

The full testimony can be found through resources.^{2,3,4}

The connection between soil life and soil moisture

Jason noted that one of the most significant findings to emerge in the last decade has been the improvements to infiltration, water-holding capacity and drought resilience when bare fallows have been replaced with multi-species covers. This improvement has been particularly evident in lower rainfall regions and in dry years.

Soil function is determined largely by its structure. In order for soil to be well structured, it must first be living. Life in the soil provides the glues and gums that enable soil particles to clump together into little lumps called aggregates. The spaces between the aggregates allow moisture to infiltrate easily (overcoming non-wetting).

Moisture absorbed into soil aggregates is protected from evaporation, so that soil remains moister for longer after rain or irrigation. Well-structured soils are also less prone to erosion.

Unfortunately, soil structure is very fragile and soil aggregates are continually being broken down. For this reason it's important to implement farm practices that encourage soil organisms to flourish and produce adequate amounts of the sticky substances required to maintain aggregation and hence water-holding capacity.

You'll find some great quotes on soil life and soil moisture in the NRCS 2014 Soil Planner.¹

The nutrient cycle and living soils

The mineral cycle also improves significantly when soils are kept alive. Maintaining a living soil often requires that rates of synthetic fertiliser be reduced, to enable microbes to do what microbes do best. Around 90% of the nutrients taken up by plants are first cycled through the soil food-web.¹

No amount of NPK fertiliser can compensate for compacted, lifeless soil with low wettability and low water-holding capacity. Indeed, adding more fertiliser often makes things worse. Tillage may provide a 'quick fix', but is detrimental to soil fungal networks and earthworms, increases the susceptibility of the soil to erosion and in the longer term depletes the more resilient forms of soil carbon.

As mentioned at the beginning of this article, NRCS publish an annual Soil Planner with the running title 'Unlock the Secrets in the Soil'. The 2014 Planner has some great quotes on soil biology and the relationship between living soils, moisture-holding capacity and nutrient cycling.¹ The inside cover contains the following:

Healthy soil: The promise of our future

There are an increasing number of innovative farmers who recognize that the promise of our future lies not just in new technology, but in getting back to basics: protecting our soil. These innovators are rediscovering that soil is a living ecosystem, and that if we are to meet the world's growing production needs while simultaneously addressing environmental and resource challenges, we must farm differently, in a way that prevents erosion, and improves the health and function of our precious top soil. These individuals are farming using principles and systems that include cover crops, no-till, nutrient management, and diverse cropping rotations that improve the habitat for the trillions of soil-dwelling microbes so they can, in turn, provide us with their amazing, life-giving benefits—all at a greater profit for farmers.

They know that farming following four basic core principles can help improve soil health, which can lead to more productive, resilient and sustainable farms for generations to come. Those four core soil health principles are:

1. Minimize soil disturbance
2. Energize with diversity
3. Keep the soil covered
4. Maximize living roots

Used in the right combination, these soil health-building principles can significantly improve the function and productivity of the soil.¹

References

- 1 2014 NRCS Soil Planner <http://nrcspad.sc.egov.usda.gov/Distributioncenter/pdf.aspx?productID=1019>
- 2 House of Representatives Committee on Agriculture bipartisan sub-committee on Conservation, Energy and Forestry hearing on the 'Benefits of Promoting Soil Health in Agriculture and Rural America'. You can view each of the presentations by clicking on the name of the witness. <http://agriculture.house.gov/hearing/benefits-promoting-soil-health-agriculture-and-rural-america>
- 3 Link to written testimonies <http://www.gpo.gov/fdsys/pkg/CHRG-113hhrg89881/html/CHRG-113hhrg89881.htm>
- 4 Link to webcast <http://agriculture.edgeboss.net/wmedia/agriculture/20140918.wvx>
- 5 Soil Carbon Challenge <http://www.soilcarboncoalition.org/challenge>
- 6 Will Brinton (2014). Cover crop innovation, water infiltration improvements demonstrated in Pennsylvania farming <http://solvita.com/cover-crop-creativity-attains-entirely-new-level-pennsylvania-farming>