The living world below our feet may hold the key to agriculture's long-term productivity growth

Over the years we have heard the arguments taking place among the proponents of commercial agriculture with their use of synthetic fertilizers and the accompanying mix of herbicides, insecticides, and fungicides, those who support the use of multi-year crop rotations including cover crops with or without synthetic fertilizers, and organic agriculture. There is also the debate among various tillage systems: conventional tillage, no-till, ridge tillage, and those who confine their equipment field passes to the same areas each year eliminating compaction of the cropped rows in the field.

If our readings are correct, the discussion is about to make a significant turn, based not on what we are doing on top of the soil surface but rather on the little-understood world that is teeming with life just below the surface. No longer is the soil perceived as a blank slate from which we wrest a crop by the force of our will and mechanical inventions.

It seems that we know much more about what is happening on the earth's surface a thousand miles away than we do about the world that is just below the grass on our lawns or the surface of our fields.

What we ultimately learn about the microbiota of our fields and lawns may bring about more significant changes to our agricultural practices than those brought about by the first plow or the introduction of fossil-fuel-propelled agricultural equipment.

According to Kathy Merrifield, a retired nematologist at Oregon State University, "A single teaspoon (1 gram) of rich garden soil can hold up to one billion bacteria, several yards of fungal filaments, several thousand protozoa, and scores of nematodes…. Most of these creatures are exceedingly small; earthworms and millipedes are giants, in comparison. Each has a role in the secret life of soil" (https://tinyurl.com/y3j962tl). A cup of soil contains more bacteria than the number of all the people who have ever lived.

Heavy tillage of fields increases the oxidation of organic matter in the soil, releasing carbon dioxide into the atmosphere. This affects the mycorrhizal fungi that "live in the soil on the surface of or within plant roots. The fungi have a large surface area and help in the transport of mineral nutrients and water to the plants. The fungus life cycle is more complex and longer than bacteria. Fungi are not as hardy as bacteria, requiring a more constant source of food. Fungi population levels tend to decline with conventional tillage" (https://tinyurl.com/y43bwgl2).

When asked about the number of different organisms in the soil, Kate Scow, professor of soil science and soil microbial ecology at the University of California Davis, said "Soil is overwhelmingly diverse, with an estimated 10,000 to 50,000 different taxa in a teaspoon of soil. These numbers are difficult to guess and keep getting adjusted as we learn more about the soil microbiome through [genomic] sequencing efforts" (https://tinyurl.com/yxtaxejh).

With all the diversity of life in the soil, the challenge is to begin to understand the interplay of the various lifeforms and strains in the soil profile and how they contribute to sustaining life on the earth including providing the food that we eat. In addition, we need to know how our agricultural practices affect the fertility of the soil.

When we spray our crops with a fungicide, does that fungicide make its way into the soil and if so what impact does it have on the beneficial fungi that help transport essential plant

nutrients to the crop's roots? As we seek to solve one problem above ground are we creating another one below the surface?

In the coming years, Congress needs to provide the USDA with a significant level of additional funding to help agricultural scientists advance their understanding of the nature of the microbiome that lives beneath our feet and the impact that various agricultural practices, including the chemicals we use, have on the health of the earth and the food that we eat.

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