A first in soil testing

Dustin Sawyer for *Progressive Forage*

AT A GLANCE

Soil testing is largely considered a settled science, but it most certainly is not. Even still, there seems to be little appetite to fund the ongoing research that's necessary to make sure that soil testing keeps pace with the demands of modern agriculture.

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Every tool we use has an evolutionary history. Evidence of this can be seen in the array of hammers that have descended from the lowly rock-on-a-stick, or the myriad of tools available to drive a screw. Sometimes it can be a fun little activity to dive into a tool's history and learn a tidbit of trivia. For example, the square-drive screw was invented in 1908 by P. L. Robertson. The Robertson screw, as it was called, was adopted by Henry Ford and used in the early Model T automobiles. Twenty-eight years later, Henry Phillips invented a self-centering screw so that automobile production could keep up with the speed demands of the assembly line. Nearly a century later, anybody can immediately identify a Phillips-head screw, but few know that the square drive was its prequel!

Of course, hand tools aren't the only kind of tools that we use in today's agriculture. Modern tools of science and technology are as indispensable to us as are the hammer and screwdriver. Chief among those tools is soil testing, and just like other tools, soil testing has an evolutionary history. What may be surprising to most, however, is that this history has been poorly curated and is under threat of being lost or forgotten. A major effort is underway to correct that, and it may be the most important agricultural development over the past half-century.

With funding from the USDA NRCS, Agricultural Research Service (ARS) and National Institute of Food and Agriculture (NIFA), along with OCP North America, the soil fertility community has undertaken the immense task of finding and collecting the data that underpin the existing soil testing paradigm in the U.S. Coined the Fertilizer Recommendation Support Tool (FRST), this project brings together more than 100 collaborators representing 44 land grant universities across the country. The task before them is huge – both in the amount of work to be done and in the impact it will have on agriculture. To understand what a big deal this is, it's important to understand the broad strokes of soil testing's history and where we currently sit.

Soil testing is deceptively simple: Measure the amount of a given nutrient in the soil, and boom, we know how much is in the soil. But here's the twist: It doesn't matter how much of a given nutrient is in the soil. What matters is how much of that nutrient will make it into the plant. This twist requires us to coin the term "plant-available" nutrients, and that is what soil testing aims to quantify. How do we measure plant-available nutrients? It depends on who you ask.

There are several schools of thought on how to measure plant-available nutrients, and detailing them all would compose an article in itself, so we'll skip those details. Suffice it to say that this is why we now have more than a dozen different phosphorus tests. Regardless of the school of thought, a soil test is always

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a system with three parts: correlation, calibration and interpretation. In practical terms, each of these parts is a series of experiments that generates data and conclusions about how a given crop should be fertilized. Keeping in mind that the experiments need to be set up and run for each individual combination of crop and nutrient, the amount of data generated by these experiments grows exponentially.

Since soil testing emerged in the U.S., each state has been developing its own soil test system. If you ever wondered why the same soil test results provide different fertilizer recommendations depending on state of residence, here's the answer. Until now, there has been no overarching infrastructure to incorporate all of the data from all of the years and all of the states under one banner.

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If we think of the number of states times the number of crops, times the number of nutrients, times the number of extraction methods, we can begin to imagine the sheer immensity of the data pool that must exist. While the conclusions of these experiments can be found scattered among research station bulletins, master's theses or official publications, much of the underlying data were never formally published. They lie in the forgotten lab notebooks or spreadsheets of our early soil fertility researchers who have since retired or moved on. In many cases, the data were discarded upon a researcher's retirement. Add in the fact that this work is also scattered across decades, both in the era of computers and prior, and the challenge of collecting and curating all of the data begins to draw to its full height.

No major soil testing innovations have occurred for several decades. Not the least among the reasons for this has been the lack of across-the-border collaboration. The FRST addresses that specifically, stating, "The primary goal of FRST is to increase soil testing transparency by promoting clear and consistent interpretations of fertilizer recommendations by removing political and institutional – public and private – bias from soil test interpretation and providing the best possible science in order to enhance end-user adoption of nutrient management recommendations."

Soil testing is largely considered a settled science, but it most certainly is not. Even still, there seems to be little appetite to fund the ongoing research that's necessary to make sure that soil testing keeps pace with the demands of modern agriculture. In the low-funding environment soil testing finds itself today, efficiency of dollars and hours is essential, and each state working privately on their research is the antithesis of efficiency – especially when a state-by-state approach isn't necessary. The framework that FRST has created allows for regional or even national-scale work to be conducted, making it more likely that soil testing tool updates will happen more quickly and frequently than ever. Already, this has spurred interstate projects that will pay farmers across the country dividends.

One such project, the Lime Project, is the first-ever attempt at tackling the wildly different lime recommendations across the country. Soon we may have regional lime recommendations that will make sense and offer easier interpretation across state borders. Another side project is looking at soil nutrient stratification in various climates and cropping systems across the country. Nutrient stratification is a significant factor impacting soil test results, and it becomes more present as more growers

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move to no- or decreased-tillage systems. A better understanding of the interplay among climate, cropping systems and tillage is essential to building a soil test paradigm that will reflect real-world nutrient dynamics.

To make progress, one must move in a forward direction, and without knowing where we've been, we cannot know if we're moving forward or backward. By collecting and curating a record of where we've been, (far from the "fun little activity" of the example above) FRST is laying the roadbed to make real soil testing progress. This collaboration brings together the brightest minds in soil fertility and, over the coming years, will significantly impact soil testing transparency and understanding. FRST is the infrastructure sorely needed to bring soil testing into the 21st century, yielding a new era of soil testing where fertilizer recommendations are more logical and consistent from region to region. You can learn more about the project at the FRST website (soiltestfrst.org).