FORUM

Long-Term Experiments: Keystones for Future Planning

There is a growing perception that present trends in global agricultural production are neither sustainable nor environmentally sound.

But that view isn't necessarily based on scientific data. Only experiments that have been meticulously carried out for several decades can answer questions about the sustainability of agricultural practices.

That's because changes in key indicators, such as soil organic matter, can take more than 20 years to become detectable by current analytical methods. And short-term experiments may miss the impacts of management changes because the measurements are taken while the system is still in transition.

As early as 1843, scientists in Rothamsted, England, established long-term agricultural experiments to learn how crop management techniques influenced yield and soil quality over time.

Later, researchers in the United States and other countries set up similar long-term projects. Some of those experiments are still running today—like the ones described in this issue that were established in 1931 at Pendleton, Oregon.

Long-term experiments can identify management practices capable of maintaining crop yield and soil quality. They show, for instance, that plowing under the plant material left behind after harvest—the crop residue—increases soil organic matter and reduces erosion.

But even as we transfer technology that supports sustainable agriculture, we have to be culturally sensitive. Growers in a developing country may readily adopt new tillage machinery. But because they need the leftover straw for feed and fuel, they may not be able to commit to techniques such as residue management. That makes it even more important to understand the impacts of various agricultural techniques and to develop better management practices.

Long-term experiments can also reveal unfavorable effects of agricultural practices, such as the repeated addition of ammonium- or urea-based nitrogen fertilizer without the concurrent addition of lime. That can make the soil more acidic. Highly acid soil is detrimental to crop growth and biological activity in soil.

Experiments like those at Pendleton have a much wider application than agriculture. They probably make up the largest temporal and spatial database currently available for determining impacts on any ecosystem. As such, they afford the possibility of harnessing observations of past change to predict future trends.

Internationally, the NATO-sponsored Soil Organic Matter Network, SOMNET, seeks to predict the effects of climate, atmospheric composition, and land use change on soil organic matter. Researchers are using data from several long-term experiments to judge the accuracy of computer models in simulating such effects.

Projects are evaluating the soil's ability to serve as a sink for carbon to mitigate global climate changes. Soil contains twice the amount of carbon as does the atmosphere, and it appears capable of storing much of the increase in atmospheric carbon dioxide if key agricultural practices are adopted.

The best long-term experiments also have an archive of soil samples that contain benefits never imagined by the experiments' founders.

For example, soil samples have been collected and archived at Rothamsted since 1843. Now, scientists can analyze these samples to determine how the levels of potentially toxic elements, such as cadmium and certain dioxins, have been changing in the soil.

A key objective for the future will be to identify and support long-term experiments that have been managed properly. Most of those existing today have survived war, drought, and politics. Commitment is needed to ensure the continuance of those with relevance and merit, as they offer invaluable insight into the research best able to guide us in the 21st century.

Paul E. Rasmussen
ARS Columbia Plateau Conservation Research Center, Pendleton, Oregon

[Parts of this Forum were adapted from an article by the author titled "Long-Term Agroecosystem Experiments: Using the Past To Guide the Future," which appeared in the October 30, 1998, issue of Science.*—Ed.]*