FROM THE Director

Expanding the Scientific Mission

As long as we see nature as passively absorbing the impacts of our interventions we will be caught by surprise by the failures of previously successful interventions. – Richard Levins, Harvard University*

In the late 1940s when my father first started using herbicides to control weeds in the grain crops on our farm, he was euphoric. Seeing all of the weeds dry up a few days after application, he was convinced that since no more weed seeds would be produced by the pesky plants we would have weed-free fields in a few years.

Of course that never happened. What happened, in fact, was that the less-invasive annual weeds were replaced by more invasive perennials. The war was on. More invasive weeds required more aggressive herbicides.

My father's experience serves as a metaphor for the need to re-examine how we use science in agriculture and other human enterprises. W. Joe Lewis with the Agricultural Research Service's Insect Biology and Population Management Research Laboratory in Tifton, Georgia, articulated the problem in a 1997 essay published in the *National Academy of Sciences Proceedings:*

> The basic principle for managing undesired variables in agricultural systems is similar to that for other systems, including the human body and social systems. On the surface, it would seem that an optimal corrective action for an undesired entity is to apply a direct external counter force against it. However, there is a long history of experiences in medicine and social science where such interventionist actions never produce sustainable desired effects. Rather, the attempted solution becomes the problem.

Success, at what cost?

A growing number of scientists now recognize that this linear approach to solving problems is part of our continuing fidelity to reductionist precepts of 17th century science and has proved inadequate. As Harvard ecologist Richard Levins reminds us, this approach has given us "great success in the small but failed us in the large."

This scientific approach gave us great success ridding our farm of annual weeds for one season, but failed us in our larger, long-term goal of controlling the weeds on our farm in an efficient and affordable manner. The same approach also has given us great successes in increasing yields of a few crops, but has not eliminated hunger. At the same time, this scientific approach has undermined the foundation of our productivity through soil erosion, depleted water resources and biological diversity, and consequently left us more vulnerable to natural disasters.

This is not to suggest that reductionist science should be abandoned. It continues to help us understand the functions of nature's specific parts and provides us with many technologies and engineering feats that have been extremely useful.

Adding needed balance

However, a reductionist approach to understanding the world must be balanced with an integrated, whole systems perspective. Reductionist science led us to believe that all of the processes on a farm could be controlled because we could master them in the laboratory or short-term experiments on research plots.

But a farm is not a laboratory. It is a living organism subject to all of the emergent properties of natural systems. This more integrative science, as Lewis suggests, must "appreciate the interactive webs in ecosystems and seek solutions with net benefits at the total ecosystem level" and provide opportunities for farmers and research scientists to work together as colleagues. This approach would "focus on harnessing inherent strengths within ecosystems," rather than relying solely on therapeutic interventions to solve production problems.

If science is to help us invent a more sustainable agriculture it must move toward a more integrated model that not only attends to the immediate results of re-engineering a plant or animal, but to all of the ecological, social and economic long-term consequences of such manipulations.

We simply can no longer afford to ignore the larger long-term failures of our short-term successes.

Re-define progress

As Levins points out, this will require a somewhat different definition of "progress" for both scientists and farmers. Progress can no longer be interpreted simply as moving from labor-intensive to capital- and energy-intensive systems, from complex farming systems to monocultures, from small scale to large scale, from dependence on nature to control over nature, from general knowledge to specialization.

If agriculture is to become more sustainable, we need to pay more attention to the inherent strengths within nature that can serve agriculture and the farmers who practice it. We need to learn more about the self-regulating and self-renewing, interdependent and efficient properties that already exist in nature.

Learning about nature requires a re-examination of our relationship with the rest of nature. The 17th century scientific revolution taught us that nature was simply a mechanical collection of raw materials waiting to be manufactured into products and systems that exclusively serve the needs and desires of humans.

We now know that nature is a highly dynamic, living, complex, emerging organism and that we are part of that evolving community. As Aldo Leopold famously reminded us, this knowledge "changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it."

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