

Will Organic Food Fail to Feed the World?

David Biello

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In 2009 he won the Internews Earth Journalism Award for his series *A Guide to Carbon Capture and Storage*, published in *Scientific American*. He continues to cover international climate negotiations and is working on a documentary on the future of electricity with Detroit Public Television. In this article, first published in *Scientific American* in 2012, Biello suggests a hybrid approach to food production that takes environmental impact and yield into account.

Food for hungry mouths, feed for animals headed to the slaughterhouse, fiber for clothing, and even, in some cases, fuel for vehicles—all derive from global agriculture. As a result, in the world's temperate climes human agriculture has supplanted 70 percent of grasslands, 50 percent of savannas, and 45 percent of temperate forests. Farming is also the leading cause of deforestation in the tropics and one of the largest sources of greenhouse gas emissions, a major contributor to the ongoing maul of species known as the sixth extinction, and a perennial source of nonrenewable groundwater mining and water pollution.

To restrain the environmental impact of agriculture as well as produce more wholesome foods, some farmers have turned to so-called organic techniques. This type of farming is meant to minimize environmental and human health impacts by avoiding the use of synthetic fertilizers, chemical pesticides, and hormones or antibiotic treatments for livestock, among other tactics. But the use of industrial technologies, particularly synthetic nitrogen fertilizer, has fed the swelling human population during the last century. Can organic agriculture feed a world of nine billion people?

In a bid to bring clarity to what has too often been an emotional debate, environmental scientists at McGill University in Montreal and the University of Minnesota performed an analysis of 66 studies comparing conventional and organic methods across 34 different crop species. "We found that, overall, organic yields are considerably lower than conventional yields," explains McGill's Verena Seufert, lead author of the study to be published in *Nature* on April 26. (*Scientific American* is part of Nature Publishing Group.) "But, this yield difference varies across different conditions. When farmers apply best

management practices, organic systems, for example, perform relatively better."

In particular, organic agriculture delivers just 5 percent less yield in rain-watered legume crops, such as alfalfa or beans, and in perennial crops, such as fruit trees. But when it comes to major cereal crops, such as corn or wheat, and vegetables, such as broccoli, conventional methods delivered more than 25 percent more yield.

The key limit to further yield increases via organic methods appears to be nitrogen—large doses of synthetic fertilizer can keep up with high demand from crops during the growing season better than the slow release from compost, manure, or nitrogen-fixing cover crops. Of course, the cost of using 171 million metric tons of synthetic nitrogen fertilizer is paid in dead zones at the mouths of many of the world's rivers. These anoxic zones result from nitrogen-rich runoff promoting algal blooms that then die and, in decomposing, suck all the oxygen out of surrounding waters. "To address the problem of [nitrogen] limitation and to produce high yields, organic farmers should use best management practices, supply more organic fertilizers, or grow legumes or perennial crops," Seufert says.

In fact, more knowledge would be key to any effort to boost organic farming or its yields. Conventional farming requires knowledge of how to manage what farmers know as inputs—synthetic fertilizer, chemical pesticides, and the like—as well as fields laid out precisely via global-positioning systems. Organic farmers, on the other hand, must learn to manage an entire ecosystem geared to producing food—controlling pests through biological means, using the waste from animals to fertilize fields, and even growing one crop amidst another. "Organic farming is a very knowledge-intensive farming system," Seufert notes. An organic farmer "needs to create a fertile soil that provides sufficient nutrients at the right time when the crops need them. The same is true for pest management."

But the end result is a healthier soil, which may prove vital in efforts to make it more resilient in the face of climate change as well as conserve it. Organic soils, for example, retain water better than those farms that employ conventional methods. "You use a lot more water [in irrigation] because the soil doesn't have the capacity to retain the water you use," noted farmer Fred Kirschenmann, president of Stone Barns Center for Food and Agriculture at the "Feeding the World While the Earth Cooks" event at the New America Foundation in Washington, D.C., on April 12 [2012].

At the same time, a still-growing human population requires more food, which has led some to propose further intensifying conventional

methods of applying fertilizer and pesticides to specially bred crops, enabling either a second Green Revolution or improved yields from farmlands currently under cultivation. Crops genetically modified to endure drought may also play a role as well as efforts to develop perennial versions of annual staple crops, such as wheat, which could help reduce environmental impacts and improve soil. "Increasing salt, drought, or heat tolerance of our existing crops can move them a little but not a lot," said biologist Nina Fedoroff of Pennsylvania State University at the New America event. "That won't be enough."

And breeding new perennial versions of staple crops would require compressing millennia of crop improvements that resulted in the high-yielding wheat varieties of today, such as the dwarf wheat created by breeder Norman Borlaug and his colleagues in the 1950s, into a span of years while changing the fundamental character of wheat from an annual crop to a perennial one. Then there is the profit motive. "The private sector is not likely to embrace an idea like perennial crop seeds, which do not require the continued purchase of seeds and thus do not provide a very good source of profit," Seufert notes.

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Regardless, the world already produces 22 trillion calories annually via agriculture, enough to provide more than 3,000 calories to every person on the planet. The food problem is one of distribution and waste—whether the latter is food spoilage during harvest, in storage, or even after purchase. According to the Grocery Manufacturers Association, in the U.S. alone, 215 meals per person go to waste annually.

"Since the world already produces more than enough food to feed everyone well, there are other important considerations" besides yield, argues ecologist Catherine Badgley of the University of Michigan, who also compared yields from organic and conventional methods in a 2006 study that found similar results. Those range from environmental impacts of various practices to the number of people employed in farming. As it stands, conventional agriculture relies on cheap energy, cheap labor, and other unsustainable practices. "Anyone who thinks we will be using Roundup [a herbicide] in eight [thousand] to 10,000 years is foolish," argued organic evangelist Jeff Moyer, farm director of the Rodale Institute, at the New America Foundation event.

But there is unlikely to be a simple solution. Instead the best farming practices will vary from crop to crop and place to place. Building

healthier soils, however, will be key everywhere. "Current conventional agriculture is one of the major threats to the environment and degrades the very natural resources it depends on. We thus need to change the way we produce our food," Seufert argues. "Given the current precarious situation of agriculture, we should assess many alternative management systems, including conventional, organic, other agro-ecological, and possibly hybrid systems to identify the best options to improve the way we produce our food."

Understanding the Text

1. What are some of the negative impacts of conventional farming methods that Biello names?
2. What did environment scientists at McGill University and the University of Minnesota find in their comparison study of conventional and organic farming methods?

Reflection and Response

3. What makes organic farming a "very knowledge-intensive" system? What are the benefits of this? What are its drawbacks?
4. What kind of hybrid approach to food production is suggested by Biello? What evidence does he present to support his argument in favor of this approach?

Making Connections

5. Biello and Margaret Mead ("The Changing Significance of Food," p. 166) both argue that we produce enough food to feed the world, but we fail to do so. Compare the evidence they each present and the solutions they recommend. Taken together, what do they suggest about the future of food?
6. What concrete ways does Biello suggest we use to fight global hunger problems? Which authors in this collection would applaud his approach? Which would critique it? Where do you stand? Which positions do you find more compelling? Why? Use textual evidence to support your response.