Scientific breakthrough promises to increase agricultural productivity by 40 percent

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A common trope among some environmentalists is that human population growth has outstripped the planet's carrying capacity and is responsible for environmental degradation. This political outlook holds that only a drastic reduction in the number of humans can avert utter disaster (see " The working class and the environmental crisis "). A corollary to this view is that because science and technology have created the environmental crisis, they will not provide solutions to it.

Newly announced research has demonstrated that genetic engineering can radically improve upon the natural photosynthetic process in plants, the basis of nearly the entire food chain on the planet. This work demonstrates that advances in science and technology, if applied rationally, can end the threat of hunger that faces large swaths of humanity. The new technology can furthermore decrease the areas of land needed to feed the Earth's population, thereby mitigating habitat destruction and increasing carbon capture, a process necessary to reverse global warming.

The work, conducted by researchers at the US Department of Agriculture, and genome research, crop science and plant biology centers at the University of Illinois, was published in the journal *Science* (South, Cavanagh, Liu, and Ort, "Synthetic glycolate metabolism pathways stimulate crop growth and productivity in the field," January 4, 2019; see also commentary by Eisenhut and Weber, "Improving crop yield").

The research reports success in overcoming a "flaw" in the photosynthetic process that, if implemented in food crops, could improve productivity by as much as 40 percent.

Photosynthesis is the process by which green plants use the energy from sunlight to convert carbon dioxide (CO_2) and water into sugars, and ultimately all other biological molecules. These in turn provide the food on which the plants themselves and animals, including humans, depend.

The rate at which photosynthesis operates is a key limiting factor in the planet's biological carrying capacity—the number of living organisms that can be sustained by Earth.

It has long been known that there is a "glitch" in the chemical process of photosynthesis, significantly reducing its efficiency. A key chemical component of photosynthesis—the enzyme RuBisCO—sometimes reverses the photosynthetic process by absorbing oxygen, normally a waste product, rather than CO_2. This results in a 20 to 50 percent reduction in plant growth due to the creation of toxic byproducts, including the molecule glycolate, that the plant must expend energy to remove. In short, not only does the plant waste energy from sunlight and fail to incorporate carbon into sugar, it must spend additional energy intended for growth to remove toxins it creates.

This flaw in the photosynthetic process and the evolutionary "fix" to clean it up are examples of how evolution produces biological systems that are not perfect, yet sufficient for survival (i.e., indicating that evolution rather than intelligent design is responsible for life on Earth).

This photosynthesis reversal process, known as photorespiration, occurs more frequently at higher temperatures. With ongoing anthropogenic global warming, the productivity of some crops on which humans depend could be significantly impacted in the future. In some cases, agricultural yield losses resulting from temperature change, aridity, storms and rising sea levels could cause food shortages, malnutrition, and famine, especially in less-developed economies.

Using genetic engineering techniques, the researchers provided plants with more efficient tools to clear out the waste molecule glycolate, a byproduct of photorespiration. In one method, the scientists introduced a glycolate removal pathway drawn from *E. coli* bacteria. In another and even more successful method, the scientists introduced a similar pathway from green algae.

Testing their methods in tobacco, a “model organism” or species commonly used for scientific study, the researchers found that plants grown in the field could achieve a more than 40 percent boost in productivity over time.

Further research will seek to introduce these modifications into food crops, a process estimated to be implemented within a decade. If successful, this new technology and related advances have the potential to significantly increase agricultural productivity at a time when the effects of climate change—including increased droughts, floods, and plant disease—threaten to have substantial negative impacts on food resources.

The development of agriculture more than 10,000 years ago (see “ New discovery sheds light on the deep roots of the Agricultural Revolution ”) was the technological revolution that permitted a dramatic expansion of the human population and, in turn, laid the basis for civilization. The newly reported research on photosynthesis and other scientific advances to enhance the disease and drought resistance, and nutrient richness of food crops have the potential to provide another great revolution in the food supply.

However, the primary contemporary cause of famine and malnutrition is not lack of resources but rather economic inequality, climate change, and war (see “ UN report on food security - One in every nine human beings goes hungry ”). The benefits of scientific advances can only be realized provided that they are employed freely and equitably under a globally planned, socialist economy, rather than monopolized by private agribusiness corporations.