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Climate Change and Agriculture

Dr. Dennis B. Egli, UK Professor Emeritus in the University of Kentucky College of Agriculture Department of Plant and Soil Sciences wrote the following article about climate change and its effect on agriculture.

It is difficult to attribute any specific weather event to climate change, after all, we had droughts, floods, and hurricanes long before we started worrying about climate change. Some argue that extreme weather events are just fluctuations in the weather, implying that normal conditions will return in the future. We all know that weather fluctuates from day to day and year to year. Climate change is not a random fluctuation.

Climate change is driven by the greenhouse effect – greenhouse gases in the atmosphere (carbon dioxide, methane, nitrous oxides, and water vapor, of which carbon dioxide is the most important) act like a blanket over the earth, increasing temperature. The higher the concentration of greenhouse gases, the thicker the blanket, and the warmer the earth. Carbon dioxide concentrations in the atmosphere have increased from 280 ppm at the dawn of the Industrial Revolution in the early 1800s to more than 420 ppm today.

In all the debate about climate change, I have never heard anyone argue that the greenhouse effect, first discovered in the early 1800s, is not real. The greenhouse effect is

increasing global temperatures. 2023 was the hottest year in NOAA's 174-year record of global temperatures.

Let's take the good news first. Higher levels of carbon dioxide in the atmosphere increase photosynthesis of crops with C3-type photosynthesis. Most crop species including soybean, wheat, rice canola, and many forage species will increase their yields unless other aspects of the environment, such as growing season soil moisture are limiting. Unfortunately, C4-type plants such as corn and grain sorghum do not respond to higher carbon dioxide levels.

Now for the bad news. Temperatures above the optimum for plant growth will reduce photosynthesis and growth, which will, in turn, reduce yield. Really high temperatures interfere with pollination and seed set, which can negatively affect grain crops. Plants growing in higher temperatures will mature sooner and probably have shorter seed-filling periods. Shorter seed-filling periods produce smaller seeds and lower yields. Crops growing in environments where temperatures are below the optimum might benefit from rising temperatures until the temperatures pass the optimum.

It's very likely that future crops will experience more water stress - too little or occasionally too much as a result of climate change. Warm air holds more water vapor so we can expect more extreme, high-intensity rainfall events. Higher temperatures increase crop water use making it more likely that crops will run out of water during the growing season, thereby reducing yield. Higher temperatures could change weather patterns and cause reductions in rainfall and drought.

Can we adjust our crop production systems to minimize the effects of climate change on food production? Warmer temperatures mean that the growing season will be longer, which will

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open areas at higher latitudes, where temperatures may be lower, for grain crop production. Longer growing seasons will also increase opportunities for double cropping. Growing soybean after winter wheat, common in Kentucky, has now spread to Northern Ohio and even Michigan. The longer growing season may make it possible to adjust planting dates and variety maturity using earlier varieties with shorter growth cycles of corn and soybean avoiding the highest temperatures of the summer.

Plant breeders and geneticists are working to develop varieties that are more tolerant to high temperatures and moisture stress. Other scientists have suggested using crops that are not currently widely grown but have tolerance to high temperatures and water limitations such as grain sorghum.

These options may reduce the effects of climate change on crop productivity, but it is unlikely that they will provide long-term solutions. Adjusting to small increases in temperature or reductions in rainfall may be possible, but I don't think we can manage our way around really catastrophic changes in the weather. For example, even drought-tolerant crops can't grow without some water. The long-term solution is to reduce emissions of greenhouse gases which will lower the carbon dioxide concentration in the atmosphere to more reasonable levels.