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Commentary Article

Charting a Path to Sustainable Agriculture

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Commentary

Whenever experts gather to talk about the future of agriculture, the one topic that comes up more than any other is sustainability.

How can farmers, both in the United States and globally, ramp up production enough in the next 30 years to meet the food, fuel, and fiber needs of an additional 2.3 billion people while maintaining, or even improving, the environmental resource base on which we and future generations depend?

For some, the path forward lies in eschewing technology in favor of organic agriculture and a retreat to simpler forms of farming. Others maintain the best route is to abandon animal agriculture and its methane producing cows altogether in favor of a vegetarian-based diet. But is either approach truly sustainable? And how should sustainability be assessed?

A new scientific paper in the journal Global Food Security

(https://www.sciencedirect.com/science/article/pii/S2211912419300719#!) by the Drought Research Council, a group of leading plant scientists and agronomists from academia and industry, attempts to answer these questions. Team members reviewed hundreds of scientific articles on everything from soil carbon to manure management to prosperity of smallholder farmers around the world while also bringing to the table their own experience and expertise from long careers focused on agriculture.

The group included Kenneth Cassman, an agronomist at the University of Nebraska who has made improving yields ecologically his life's work. In a previous review article, Cassman had laid out four objectives that an agricultural system must be able to achieve to be considered sustainable:

- Ensure production of an adequate food supply,
- Alleviate poverty,
- Achieve better health and nutrition for a growing population, and
- Conserve natural resources.

These objectives, which can be applied across geographies and development levels, also dovetail well with the Sustainable Development Goals developed by the United Nations in 2015.

As the new paper in Global Food Security makes clear, one major difficulty is that these four objectives are often in competition with each other and success in one can lead to failure in another. For example, using these criteria, organic production can't be considered sustainable because even though it can be a great option for farmers or food companies to achieve greater profit for their products and offer consumers another choice, organic can't achieve the yields per hectare needed to meet future demand without a dramatic increase in land use, thereby destroying natural resources. And the same is true for abandoning animal agriculture. Although there are many who opt for a vegetarian or vegan lifestyle for health or animal welfare reasons and there may be merit for the well-fed to eat less beef, removing all meat from the global market would mean losing a much-needed diversification of diet and improved nutrition and damage the livelihoods of millions of farmers around the world who rely on livestock and poultry products for a living.

Fortunately, as the paper clearly shows, there is one road that meets a lot of the criteria for achieving a system of sustainable agriculture, and we're already on it. Modern, biotech-friendly, high-tech adopting, throughput agriculture the kind practiced on most U.S. farms – has demonstrated the ability to improve the livelihoods of farmers while providing an abundance of food, keeping prices low, and increasing choice for consumers. Often not recognized is that the yields obtained per hectare of crops such as maize can be ten times higher than those obtained by many farmers in the

developing world. Our future food needs globally could not be met without a major contribution from these intensive forms of agriculture.

This science-based approach to agriculture has certainly done much toward meeting Objectives 1-3. With respect to Objective 4, the record is mixed but fast improving. Certainly, achieving high yields per hectare conserves land and thus can protect vital natural resources. But there are some trade-offs that have given big ag a bad name by some environmentalists. But this type of technology-based agriculture has made tremendous progress just in the past few decades confronting these challenges. Fortunately, regarding water use, much of the U.S. corn-belt is rainfed (although we must relay upon science to help farmers adjust to future climate change). For drier areas, improved irrigation management combined with improved crops such as modern hybrid maize has improved water use efficiency. Soil management has not only created healthier soils that help farmers increase yields but has increased carbon sequestration in the soil. Sophisticated monitoring of nutrient use and soil characteristics means that fertilizer use in the U.S. has flattened since the 1970's while yields continue to climb. And don't forget that livestock and poultry support sustainability objectives 1-3, and even if livestock were totally eliminated in the U.S. greenhouse gas emissions would be reduced by less than 3%.

By contrast, agriculture in much of the developing world faces a range of very different challenges. Many smallholder farmers are organic and low yielding not by choice but because they lack access to fertilizer, pesticides, and herbicides. Access to modern seed varieties, poor storage and transportation and weak markets are additional challenges. Livestock production is limited by over-grazing and diseases, and the uncertainties created by climate change threaten all progress for improvements in the yields of both crops and animals. Thus, while this type of agriculture may get a good rating for some aspects of ecological sustainability, it falls woefully short on objectives 1-3. The good news is that smallholder farming in Asia continues to improve in productivity. And while uneven, progress is now being seen in some African countries such as Ethiopia where government support, scientific training, and adoption of newer technologies are playing key roles.

There's no question that significant challenges remain on the road to achieving sustainability in agriculture and that the challenges can vary depending upon the farming system. In the U.S., new discoveries and technologies are increasingly focused on issues of sustainability. For the developing world, we already know how to address many of the challenges, and, where applied, progress is clearly evident. Yet the pressures of rising populations coupled with the uncertainties created by climate change call for even greater investment in applied and basic science for agriculture from both the private and public sectors. China is investing heavily in agriculture, and their scientists are filling journals with high quality research results. The U.S. needs to keep pace, especially for our land-grant university system that has been the bread and butter of research since the 1860s when first established. Policy improvements are needed around the world to ensure that key inputs, training and new technologies are evenly available, especially in those countries and regions most in need. We must find ways to produce more food where it is consumed. And if farmers are going to provide healthier soils, reduce CO2 in the atmosphere, use soil nutrients ever more carefully, while providing a high quality and affordable food supply, should they bear the entire burden for continually paying for these improvements, especially as the long-term trend of lower commodity prices paid to farmers continues? Fortunately, options are being developed for partnering with farmers to share the burden of providing ecosystem services in ways that are economically viable for all.

As the paper from the Drought Research Council clearly illuminates, agriculture is an incredibly complex and intertwined web of political, financial, social, and cultural systems that we all depend on for sustenance. Even if every farmer in the world were to incorporate proven science-based breeding and production strategies, farmers alone cannot achieve the four sustainability objectives or meet the United Nation's Sustainable Development Goals. It will take all of us -- individuals, governments, and institutions – supporting increased investment in agricultural research and sustainability strategies and approaches, including public policies that are based on sound science. We may be on the right road to achieving sustainability but it's not enough to simply stay the course.

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Conflict of Interest

There is no conflict of interest to declare.