Kelly Gravuer
Major: Ecosystem and Landscape Ecology (focusing on the microbiome of agricultural soils)
Year in school: Final (6th) year of PhD

The Greatest Challenge Facing Agriculture Over the Next Five Years

In recent years, many discussions in the agricultural sector seem to center on the same fundamental problem: *how can we supply nutritious food to a growing population while at the same time improving environmental and human welfare within the production system – all while building resilience to an increasingly extreme and unpredictable climate?* Within the next five years, we will make a number of choices that will dramatically impact the nature and scale of our solution to that problem. In the United States, the most critical near-term challenge is to maintain a large and diverse suite of farm operations – including a substantial number of both small and midsized farms. I contend that many creative solutions to our longer-term challenges will flow from effectively addressing this near-term issue.

America's farm owners and farm workers (hereafter, "farmers") are the ultimate source of on-the-ground innovation. Academic and industry-based agricultural researchers are making important discoveries at an increasingly rapid pace, as new technologies such as inexpensive DNA sequencing dramatically expand our knowledge of plants, animals, and soils. Yet, the controlled experiments that scientists must do to understand biological processes bear little resemblance to the complex web of interrelated decisions that farmers must make every day. To determine which new technologies will truly help American farmers to meet individual and societal goals, the performance of each technology must be evaluated within complex real-world operations and adapted as needed. Farmers are the drivers of these critical improvements, creatively adapting emerging technologies to achieve their operations' objectives.

Furthermore, because so many important factors – such as soil type, crop type, field size, and distance to processing facility – vary from farm to farm, new technologies must be evaluated and adapted in a large number of contexts before their potential can be fully understood. In other words, unlike the laws of physics, the key determinants of a technology's agricultural value are often quite local. A large and diverse suite of farm operations is therefore essential for research advances to reach their potential for supporting sustainable and resilient intensification.

Yet, this challenge rises to the fore not only because of its importance, but also because we will need to reverse current trends to achieve it. As Secretary Vilsack has highlighted, the 2012 Census of

Agriculture showed an "eroding middle," with land in 100-499 acre farms decreasing by 5.6% between 2007 and 2012 while land in 5000+ acre farms increased by 3.9%. As of 2012, farms with over $1 million in sales accounted for only 4% of farms, but 66% percent of all sales. Midsized farms are particularly important for vetting new technologies because, unlike smaller farms, they often provide a family's primary source of income and can therefore provide information on a product's utility when profitability is a paramount consideration. In this light, the recent decline in midsized farms represents a particularly troubling loss in America's ability to adapt new technologies toward large-scale agricultural solutions.

In over a decade of research in biological systems, I have learned that detailed field observations are essential to determining why new management techniques and technologies succeed or fail on the ground. While very large farms can make important contributions to field-testing and adapting new technologies, the more personal familiarity that small and midsized farmers often have with the unique features of each of their fields can make critical contributions to understanding why successes or failures occur. For example, performance of a new fertilizer formulation may be determined by small-scale variations in soil drainage that aren't apparent on larger-scale field maps, or insect emergence at different times in different parts of a field may explain why a new insecticide spray works in some areas but not in others. Despite everything we know about agricultural systems, biology often surprises us – and there is no substitute for direct, detailed observations for unearthing the causes of those surprises. As Scott Park, an agricultural leader in Sutter County, California says, "farming with the five senses, in addition to hard data" is critical to effective problem-solving. Small and midsized farms provide important forums for these experience-based solutions.

Defining policies and programs that will promote the success of small and midsized American farms is undoubtedly a challenge. Such programs must understand and address limiting factors for an extremely diverse range of operations within a difficult-to-predict economic and environmental landscape. At the same time, the potential impact of these programs on other national priorities, such as equitable access to nutritious and affordable food, must be carefully considered. Still, I believe that supporting this productive and creative group of innovators is the most important near-term strategy we can employ in order to realize our long-term goal of resilient and sustainable intensification. America's farmers have shown an incredible ability to continue feeding the nation and the world in the face of a formidable range of past and present challenges. With thoughtfully-designed support, they can be indispensable allies in confronting the challenges of the future.