Food security for the future

Avoiding agricultural disaster requires existing technologies to restore microbiomes to food systems while empowering growers and consumers to engage in sustainable food production, distribution and consumption

DESPITE THE INCALCULABLE importance of food to health – not only of our own bodies, but that of the ecosystems within which they are fostered – it's alarming just how little thought consumers can give to where food comes from and how it has been produced before reaching for their plates.

The Green Revolution (GR) of the mid-20th Century may have temporarily alleviated the grasp of famine on the developing world thanks to the advent of innovative agriculture procedures, but it also had an unfortunate knock-on effect to the environment and the nutritional security of our food. Agriculture is an immensely complex and indisputably important part of global society; which invariably means that those with control over its machinations must have intimate knowledge of numerous local factors that interact to influence food security in any location.

Industrial advances in agriculture have tended to focus on uniform and narrow objectives such as crop yield or pest control, utilising synthetic fertilisers, herbicides and pesticides, with little thought for long-term impacts on microbial communities in plants and soil or on human nutrition. Indeed, these methods often fail to meet local-scale food demands or restore lost ecosystem services. Couple this with an ever-increasing human population, climate change and rising food/energy demands and a desperate need for improved crop production practices becomes apparent.

Though agricultural improvements have vastly increased the scale with which we can produce foods, it is a distressing fact that our global population includes almost 1 billion individuals who suffer from chronic hunger, as well as a far less accurately tabulated global percentage who suffer the broadest terms of malnutrition, including the nutritional deficiencies that lead to cancer, heart disease, obesity, and other chronic diseases. It is clear that without devising new ways to tackle the socioeconomic and ecological factors at play – not just monetary goals such as crop yield – global health will fall into steady decline.

MICROBIAL SYSTEMS ARE KEY

The research efforts of Dr Mary Lucero and her colleagues have focused on exploring the microbial interactions between: plants and their surroundings; epiphytes along plant surfaces, endophytes within plants, and rhizosphere and soil microbes on subsurface plant organs and soil interfaces. Many of these naturally occurring processes have direct parallels to agrochemical technologies aimed at enhancing crop production. For example, microbes can produce alkaloids that fend off insect pests (replacing the need for pesticides), fix atmospheric nitrogen, solubilise phosphorous and other minerals (effectively rendering synthetic fertiliser unnecessary) and vastly improve soil aeration and water holding capacity – two factors that may greatly reduce the need for intensive irrigation and deep ploughing.

In 2006, Lucero and the late Dr Jerry Barrow both employed by USDA-Agricultural Research Service at the time, filled US Patent US7901927 illustrating how the simple transference of microbial endophytes from a native plant to a crop plant can provide an incredible boost in the plants productivity and yield. At the time, they believed this simple process would one day make genetic modification obsolete.

With the emergence of new metagenomic tools however, it was revealed that the consortium of microbes living inside a micropropagated plant was more complex than Lucero and Barrow had initially realised: "We originally believed our method promoted transfer of a single endophyte that persisted exclusively inside the plant," Lucero points out. "Over time, we found that we were transferring entire endophyte communities, and that persistence was not always ensured." This made results highly variable across different environmental conditions, prompting exploration of naturally occurring factors that regulate microbial community development.

In time, the group recognised that facilitating natural microbial community development in soils was more likely to produce stable, robust, and resilient crop systems than conventional agriculture, genetic modification or endophyte transfer techniques could offer. Managing to foster natural soil microbial community health would also reduce chemical usage, improve food quality, enhance soil, and make production safer and more economically feasible for growers.

SHIFTING SOCIAL PERCEPTIONS

Recognising that technologies for restoring microbial communities are readily available at large and small scales, and that continued disruption to the natural alignment of microbes and systems will inevitably lead to an agricultural collapse, Lucero co-founded End-O-Fite Enterprises LLC (EE) to engage in the mission of restoring natural microbial diversity to agricultural systems and human health. In collaboration with university partners, EE provides technical support to growers and non-profits who are converting to microbial-based production methods.

EE also works to address the social factors driving food production and diet selection. These efforts include educational approaches that highlight economic, environmental and nutritional health factors influenced by how and where food is grown; approaches that foster appreciation for microbially enhanced nutrition; and approaches that empower individuals to accept personal responsibility for broader aspects of food security. Home and community gardening are presented as critical avenues, not only for producing food, but also for enhancing multidimensional and experiential understanding of the factors that influence food quality.