SSSA President’s Message

Soil Science May Be Key to Cracking the Food Security Code

In my column in the February CSA News magazine, I suggested that the soil science community should respond to this challenging time because of the broad societal interest in issues that strongly relate to soil science, such as a changing climate, availability of fresh drinking water, environmental footprint of humans, and the future need for safe and healthy food. This month, I would like to highlight the food security topic, and make the case that soil science research will be crucial in meeting our future food demands. I do this, realizing that so much attention is paid to constraints of water and effects of a changing climate on crop production, as well as to its environmental footprint. Rightly so, yet the general discussion and literature is largely absent of the enormous relevance of soils and the biophysical limitations that soil may present towards achieving the higher crop yields that are called for.

Let me start with reviewing the context of the need to feed two billion more people in the coming 40 years. First and foremost, essential inputs to crop production are provided by land, energy, water, and nutrients. With the exception of solar energy driving photosynthesis, their combined availability is determined by soil physical, chemical, and biological processes, as well as by effective soil management practices that minimize land degradation (such as by erosion or salinization) and protect the natural environment. Much innovative soil research will be required, including collaborations with our colleagues in the crop and animal sciences, as well as with hydrologists and ecologists, to crack the immensely complicated food security code.

Peak Soil

Much of the agricultural land is converted to urban and industrial use. According to the UN, over the past 40 years, about 2 billion ha of soil, making up 30% of the world’s cropland, has been degraded and is now unproductive. A recent USDA report states that between 1982 and 2007, close to 10 million ha of U.S. agricultural land has been converted for development. In other parts of the world, productive soils are available, however, at the expense of natural grasslands, savannas, and forests. Opening these soils for agriculture is likely to have huge ecological impacts, while at the same time pushing huge quantities of greenhouse gases into the atmosphere. One may argue that we are reaching the point of peak soil, that is, the world is approaching its maximum land surface area available for agricultural production in the future.

Staggering is the amount of water required for producing food. Though largely depending on the relative proportion of animal and plant protein consumption, a typical daily diet requires about 1 L of water for each kilocalorie of food intake, corresponding to a total of 2,000 L (near 600 gal) of water for a 2,000 kcal daily diet. In rainfed agriculture, most of that water is “green water,” coming from soil water storage by rainfall. However, in many of the world’s hydro-climatic regions, there is just not enough rainfall, and additional irrigation water is required from either pumping groundwater or reservoir storage. As a result, about 15% of the world’s agriculture is irrigated, producing nearly 45% of the global food production, but using about 70% of this developed “blue water,” globally. Therefore, much emphasis recently has been on availability of blue water, either regionally or globally. However, with few exceptions, there isn’t much more water to develop. In many irrigated regions of the world’s river basins, stream flows have been decimated, beyond to what would be environmentally acceptable. To make matters worse, recent studies confirm the yield-reducing effects of increasing temperatures by climatic change and the need to expand irrigated crop area to maintain crop productivity levels.