Making More Cropland by Tinkering With Plants

The heart of America's riches has always been its land.

It was the promise of land that lured many of the men and women who settled this country, starting with the 104 English who landed at Jamestown, Virginia, in May 1607. As the nation grew, its patterns of settlement were shaped by the quality of the land (and availability of water).

Anyone who's ever flown coast to coast can hardly fail to marvel at the vastness of the United States. As one English bride remarked when she first came to this country with her American husband and flew from New York to California, "After we'd gone as far as Iowa, I simply couldn't believe it."

In fact, the land mass that encompasses the 48 contiguous states totals 1.9 billion acres—but so does the Sahara desert. The crucial element is the quality of the land, not the quantity.

According to USDA statistics, the United States—excluding Alaska—has 423 million acres of cropland, ranging from Class I land, which has no significant limitations for crop production, to Class IV, where crops should be grown only under carefully selected land management practices.

Another way to assess land quality is to use the classification of "prime farmland," defined as possessing the growing season, moisture supply, and soil quality needed to sustain high crop yields when treated and managed according to modern farming methods. Our grand total of prime farmland—232 million acres—is barely more than 1 out of every 2 acres of U.S. cropland, again excluding Alaska.

As any gardener can tell you, success in growing specific plants—like real estate values—often comes down to location, location, and location.

Agricultural producers must frequently wrest their crops from land plagued by poor drainage, limited root zones, limited natural fertility, poor water availability, or high erosion potential, as well as by a poor mix or outright shortage of soil nutrients needed for plants to thrive.

Agricultural Research Service scientists are well aware of these problems and have worked to develop crop varieties and soil management systems that can deliver economic yields under less than ideal growing conditions. ARS supports one of the world's few laboratories dedicated primarily to the study of that intricate relationship between soil and plants, the U.S. Plant, Soil, and Nutrition Laboratory in Ithaca, New York.

In this issue of *Agricultural Research* magazine, you'll read about how ARS researchers in Ohio and Georgia are developing soybean and wheat plants that can grow under flooded conditions and how they've traced the secret of survival to the plants' roots, strangely riddled with air passages.

Other ARS researchers have also tackled aspects of the dilemma of growing crops in inhospitable settings. Some of their findings:

- At the Ithaca lab, scientists discovered that plants may have a sensitive spot at the tips of their roots when it comes to exposure to aluminum. Aluminum toxicity is the primary problem limiting agricultural production on acid soils, the type of soil seen in about half of the world, including the northeastern and southeastern United States, South America, and Africa. In laboratory tests, when aluminum was applied to other parts of the roots, the plants were able to function normally. But when aluminum was applied to plant root tips, root growth was inhibited within a matter of hours. The scientists say excessive aluminum also interferes with plants' ability to take up essential calcium from the soil.
- Crops such as cotton and corn might borrow genes that give extra drought tolerance. When dried star moss, *Tortula ruralis,* is given just a few drops of water, it changes quickly from a rusty brown mass to lush, green individual branches with star-like needles. ARS researchers in Lubbock, Texas, isolated 74 proteins thought to be involved in the repair process because they increased in numbers within 2 hours after the moss was moistened.
- A group of special proteins that corn plants produce at times of drought or salty conditions could hold the key to developing plants that can better withstand such adverse conditions. ARS laboratory studies in Hawaii showed that when clusters of corn cells were subjected to too much salt or too little water, the cells manufactured three proteins not found in other cells free of such stresses. Likewise, when corn seedlings were deprived of water, they reacted by making two other proteins not produced by their well-watered counterparts. Those two quickly disappeared when the tiny plants were watered.

Each of these discoveries is just one small part of the gigantic puzzle of soil-plant-environment interactions. But with the world's population expected to climb from its current 5.8 billion to 10.4 billion by the year 2100—and a limited base of arable land worldwide—every new bit of information that helps us make the most of our available agricultural land could prove vital in the effort to produce enough food in the years to come.

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