America's Farms: Growing Food, Fiber, Fuel—and More

The year was 1944, and USDA scientists in Albany, California, were laboring over a new, time-saving method for converting wheat starch into ethanol. With World War II under way and the country facing an industrial ethanol shortage, those researchers were bent on streamlining ethanol production with a revolutionary starch-degrading scheme.

The Albany location was one of four regional "utilization" research centers opened in 1940. The three others were at Wyndmoor, Pennsylvania; Peoria, Illinois; and New Orleans, Louisiana. The centers' main purpose was to discover and develop new uses, especially industrial ones, for the agricultural abundance being produced by U.S. farmers.

Today, half a century later, ARS researchers are still committed to finding technologies that will not only unlock the vast energy potential that's tied up in our nation's renewable farm resources, but also expand the array of products possible from these materials.

In the 1940s and 1950s, ethanol was valued as an industrial solvent. Now this homegrown energy source has assumed a much loftier position: an alternative to imported petroleum. Ethanol production and use is approaching 3 percent of our total national fuel consumption today and is expected to reach about 7 percent by the end of this decade.

But as attractive as ethanol is, its relatively high production cost remains an important limitation. So ARS is working to solve problems associated with ethanol's efficient and economical production.

For example, researchers in Peoria are studying versatile microorganisms that can tolerate the temperature and chemical extremes characteristic of ethanol production. Such remarkably resilient microbes—some of which are so temperature-tolerant that they've been found in hot springs—might allow producers to combine, or even skip, certain bioprocessing steps.

Increased knowledge of such energy-friendly microbial helpers could further improve efficiency of converting starch, cellulose, and other sugar-based biomaterials to ethanol and significantly slash production costs.

Also critical to improving the economics of ethanol production is creating new uses—and markets—for the coproducts of fuel generation. Huge quantities of nondegradable plant residues resist conversion, and as ethanol production soars, even more will be generated. Most of these cellulosic leftovers are marketed as dried distiller's grains and used as livestock feed.

But ARS microbiologist Paul Weimer has found at least one potential use for such unconverted cellulosic bits. In his studies with microorganisms that inhabit cow stomachs, Weimer has identified microbes that hug plant fibers so tightly that they make the ideal basis for an all-natural, petroleum-free glue. (See page 8.)

If the United States is to meet the federal government's ambitious goals for clean and renewable energy, researchers must find more and better ways to break down plant matter in the form of cellulose—one of the most abundant renewable resources on the planet. Key to doing this will be understanding how it's built, on a molecular level.

So ARS scientists, including chemist John Ralph at the agency's U.S. Dairy Forage Research Center in Madison, Wisconsin, are zeroing in on plant cell walls to see exactly how one of their most significant architectural components—lignin—is made. (See page 4.) That information will improve our capability to modify plant cell walls so that they'll be more likely to release their sugars for ethanol fermentation.

There's little question about whether U.S. farmers can grow enough crops for large-scale processing into biofuels and other biobased products. For decades, ARS scientists have steadily worked to increase yields and profitability through plant breeding, improved agronomic practices, better postharvest packing and storing methods, and other sustainable and profitable strategies.

But for ethanol production, it's a matter of figuring out which crops—like corn, switchgrass, or sugarcane, for example—are most profitable and geographically appropriate to exploit. By tweaking plant genes, scientists can encourage production of more biomass or change a plant's cell wall composition to optimize its suitability for energy and fuel production or for other industrial uses such as lubricants, inks, fabrics, or glue.

And we're not just interested in the "big players," when it comes to evaluating or modifying plants as feedstocks—or starting materials—for biofuels production. ARS researchers are also evaluating lesser-known plants with energy potential, such as the field pea and corngrass. Diversifying the number and type of feedstocks grown will help insure against catastrophic losses caused by weather or disease.

ARS's decades-long history of identifying, collecting, and preserving diverse plant species in its 20 plant genebanks across the country puts the agency in a unique position to design, develop, and produce sustainable energy crops for the future.

And finally, if renewable energy resources are to remain so, they must be managed accordingly. Implementing sustainable agricultural practices that also boost America's rural communities will help to maintain our farmers' economic health as we establish long-lasting national energy independence.

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