

## *Biobased Products: America's Second Green Revolution*

The great increases in wheat and other grain yields that occurred in the 1960s are often referred to as the Green Revolution. But America's second agricultural green revolution—under way today—can be traced back almost 100 years to the work of noted botanist George Washington Carver.

Since Carver's death in 1943, generations of schoolchildren have learned about his finding hundreds of uses for peanuts in the early years of the last century. But few realize that this visionary was also helping farmers and his country by making biobased products—industrial products made from renewable resources rather than from finite petroleum supplies.

In the process of laying the groundwork for a future plant-dependent economy rather than a petroleum-dependent one, Carver also contributed to rural economic improvement. His products offered farmers alternative crops that were beneficial for them and their land. Today's accelerated shift towards a plant-dependent economy also holds that promise. This time, the soil-building legume is not peanuts, but alfalfa, which is also being used to produce industrial products and considered as a source of ethanol. And ARS' work with guayule, a native shrub, to produce hypoallergenic latex for surgical gloves and other products promises to help farmers in the American Southwest.

Work on biobased products has been carried out at four ARS regional research centers since Congress authorized their construction and operation over 60 years ago, and charged them with finding new uses for farm commodities. The story on page 16 cites some examples of their accomplishments, including a compound made from citrus peels and pine tar that works better than a petroleum-based chemical for making rubber. The article also mentions soybean ink; Super Slurper, a cornstarch-based product used in everything from batteries to baby powders; and improvements in vinyl plastics with the use of animal fats and vegetable oils.

The need to improve rural economies is still of concern today, as it was in Carver's day. Biobased research promises to spawn new industries that need to be near their raw-material sources in rural America, where jobs are desperately needed. Each region of the country offers its own niche market.

The article on biofuels on page 4 shows that while corn and soybeans are the dominant sources of ethanol and biodiesel, respectively, and will almost certainly remain significant players, other possible sources include alfalfa and switchgrass. Up to now, ethanol has been made from crops with high sugar and starch content that are usually used for cattle and human food. Scientists are looking at making ethanol from cellulose, which is found in grasses, shrubs, and trees.

Use of wastes—rural, urban and industrial—is increasing in importance in biobased product and fuel production. They

may be used in combination with each other or with fossil-based fuels. An example is ARS' partnering with the U.S. Department of Energy (DOE) to test the generation of electricity from methane given off by manure. Carver's main motivation for finding industrial uses for peanuts was to create new markets for crop surpluses, so creating new markets for waste would not surprise him at all.

The 1960s brought up new environmental concerns that created a climate favorable to development of alternative fuels. The 1973 oil embargo gave more momentum to this shift.

But in this century it may be biotechnology that furthers the shift beyond even Carver's vision. Besides making the biobased-products manufacturing processes more efficient, biotechnology is also creating new byproducts, or coproducts, that further lower costs.

Still, technology is only about 10 percent of the process. The other 90 percent is policy. To that end, Executive Order 13134 calls for tripling America's use of biobased and bioenergy products by 2010. The Biomass Research and Development Act of 2000 teams USDA with DOE to promote biobased products. Executive Order 13149 calls for a 20-percent reduction in federal vehicular use of petroleum by 2005. The Clean Air Act of 1990 is another prod for biobased fuels. There are a growing number of tax incentives and public and private subsidies that shrink the price gap between biobased fuels and petroleum fuels.

The next Farm Bill is likely to have further incentives for biobased products, including a target for federal agencies to make at least 5 percent of their purchases be biobased products where possible. Congress recently provided new funding for ARS: \$8.8 million for bioenergy research and \$3.2 million for biobased products. ARS has two national programs that deal with various aspects of developing these kinds of products.

Bioenergy and industrial crops have benefits in addition to providing more environmentally sound products. They add diversity to America's rural landscapes, and when grown as buffer strips at field edges, they provide wildlife habitat.

The debate over plant- versus petroleum-dependent economies is not new; petroleum won it in the 1940s after World War II. Once again, the state of American public opinion is highly aroused, and the debate has been renewed with vigor. This time around, the betting may be in favor of the plants. In this new century, the biological sciences are likely to lead the way to the formation of new industries as the physical and chemical sciences did in the past century.



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