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Forum: Innovations Through Biotechnology

Jack Okamuro
ARS, Jack.Okamuro@ars.usda.gov

Kay Simmons
ARS, Kay.Simmons@ars.usda.gov

FORUM

Innovations Through Biotechnology

"We need to put a premium on creating innovative solutions to address our current and future problems."—U.S. Department of Agriculture Secretary Tom Vilsack on priorities for the 2012 Farm Bill

This month in *Agricultural Research,* we highlight Agricultural Research Service projects grown from seeds planted on what were once the distant horizons of biotechnology—metagenomics, genomic selection, metabolomics, and more.

Each project represents a fusion of leading-edge science and technological innovation that is helping to shape ARS's response to the growing food, fiber, and fuel needs of a U.S. and world population forecasted to exceed 430 million and 9 billion individuals, respectively, by 2050.

Take, for example, the field of metagenomics, an exciting new discipline that involves sampling the DNA code, or genome sequences, from a community of microorganisms en masse. That community may have diverse origins—from a drop of ocean water to a pinch of soil or even a swab from the intestinal tract of a diseased farm animal.

ARS scientists Laszlo Zsak and Michael Day, both at the Southeast Poultry Research Laboratory in Athens, Georgia, and Brian Oakley and Bruce Seal, of the Richard B. Russell Research Center there, used the metagenomic approach to analyze RNA and DNA viruses associated with two major enteric diseases in poultry: poult enteritis complex and poult enteritis mortality syndrome (see "Metagenomics Offers Insight Into Poultry Diseases," page 18).

They found a new, unexplored universe of viruses, from common RNA viruses (astrovirus, reovirus, and rotaviruses) to an abundance of unexpected viruses (picobirnaviruses and caliciviruses).

One DNA virus genome sequence in particular has them excited. It is a previously undiscovered bacteriophage, named "phiCA82," that is related to viruses that infect and kill bacteria. Studies are under way to determine if phiCA82 and other new phages encode enzymes that can be used to destroy pathogenic bacteria and may provide an alternative to antibiotics for treating animals.

In plant breeding efforts, ARS scientist Jean-Luc Jannink at the Robert W. Holley Center for Agriculture and Health, in Ithaca, New York, is leading the charge for enhancing future crop designs with the use of "genomic selection"—the statistical analysis of genomewide marker data to predict the breeding value for selected progeny, including small- and large-effect trait genes (see "A New Approach to Molecular Plant Breeding," page 13).

Jannink and university collaborators showed that recent advances in genomic selection can dramatically increase genetic gains per unit of time and cost for wheat and barley. When combined with year-round nurseries and inexpensive, high-throughput genotyping platforms, genomic selection will enable breeders in the future to develop new varieties more quickly and efficiently.

In human nutrition, ARS scientist James Harnly, at the Beltsville [Maryland] Human Nutrition Research Center, responded to a critical need in the dietary supplements industry for validated analytical methods to identify diverse metabolites in supplements containing botanical materials.

The adaptation of metabolomics—high-resolution analysis of metabolites using mass spectrometry—to analyze dietary supplements has provided important new insight into the chemical composition and quality of these popular products (see "Digital Detectives Decipher Ingredients," page 6).

Finally, in food safety, ARS scientists created a new generation of advanced antimicrobials. At the Animal Biosciences and Biotechnology Laboratory in Beltsville, David Donovan showed that hybrid enzymes, produced by genes that combine activities from two or more phage enzymes, can target and destroy pathogenic bacteria in nature. Two such bacteria are major pathogens of dairy cattle—*Staphylococcus* spp. and *Streptococcus* spp., including methicillin-resistant *Staphylococcus aureus,* or MRSA. (This research is expected to be reported in an upcoming 2012 issue of *Agricultural Research*.)

Like the new generation of hybrid vehicles, hybrid antimicrobials combine the best features of their parent compounds—lytic activity and species specificity—thus reducing the probability that bacteria will develop resistance.

All projects highlighted in this issue of *Agricultural Research* would not be possible without the contributions from the innovative scientists and staff of ARS who are exploiting new scientific discoveries and technologies to develop solutions for agriculture's great challenges and priorities.

Jack Okamuro
National Program Leader
Crop Production and Protection
Beltsville, Maryland

Kay Simmons
Deputy Administrator
Crop Production and Protection
Beltsville, Maryland