A Few of the Many—

Outstanding ARS Accomplishments

A millennium issue would not be complete without listing some of the outstanding accomplishments achieved since the Agricultural Research Service was officially formed in November 1953.

ARS scientists have conducted many thousands of research projects over the agency's 46-year history. Some have improved life for everyone. ARS research has led to better soil management; improved use of fertilizers; enhanced strains of seed; advanced controls of insects, diseases, and weeds; and superior methods of harvesting, storing, and transporting farm products to market.

Some of these creations—such as frozen foods—have become multimillion-dollar, or even billion-dollar, industries. Others, like cryogenic seed preservation research, may have an even greater significance when breeding crops for the world's future food supply.

Our main criterion for screening accomplishments was their impact on society, civilization, or the world as a whole. Experience has shown that some findings can take years, even decades, for their impact to be felt.

When it comes to writing the history of ARS accomplishments, ARS experts will most likely disagree over the ranking of what is most important. This list of 15 achievements—in no particular order—has been selected from back issues of *Agricultural Research*; Ernest G. Moore's *The Agricultural Research Service*; two volumes by Hubert W. Kelley, *Science On A Human Scale* and *Always Something New*; back issues of the *Quarterly Report of Research Progress*; and *Science in Your Shopping Cart.*

Beltsville Sperm-Sorting Technology allows livestock producers to predetermine the sex of their animals by separating living female-producing X-chromosome sperm from male-producing Y-chromosome sperm, based on the content of their genetic material, or DNA. To date, hundreds of healthy and normal animals have been born using sexed semen. The technology has been licensed by ARS for use in animals and in human medicine.

Research on vaccines and other controls for avian leukosis, a major chicken disease, has helped to define the characteristics of these and other retroviruses, showing that they continually evolve to produce greater virulence. Besides being used on more than 80 percent of broiler chickens in the United States, the technology may give cancer researchers and human immunologists—including AIDS researchers—a clue as to how cancer and the AIDS virus work. Like AIDS, avian leukosis is caused by a retrovirus.

SCOTT BAUER (K8322-16)

Field of soybeans.

Soybeans, once a minor forage crop in the United States, are now the nation's second most valuable crop. ARS scientists did this by breeding soybeans with resistance to root knot nematodes and to several foliage-feeding insects. Soybeans are high in protein and other nutrients. They also have isoflavones, which studies suggest have cancer-preventing properties. The United States produces 15 billion pounds of soybean oil annually, with a market value of about $4 billion.

Sterile insect release technology has transformed insect control strategies from depending almost entirely on chemicals to curbing pest populations by disrupting their reproduction. The revolutionary new technique has been used effectively against screwworms, Mediterranean fruit flies, gypsy moths, boll weevils, and tsetse flies. Against screwworms alone, the technique has saved an estimated $48 billion in the cost of producing meat and dairy products. Sterile release has eradicated screwworms in the United States, Mexico, and in part of Central America.

Universal Soil Loss Equation was a pioneering use of computers for solving agricultural problems. The USLE models how soil erodes and is used

worldwide for managing land to keep it sustainable. It is a major weapon in combating the annual loss of 2 billion tons of soil that wash away from America's cropland. It has also become the prototype for all expert systems that attempt to model natural processes.

Fire-resistant textiles became possible with THPC, a compound that prevents cotton fabrics from flaring up when held in a flame. Instead, they form a tough, black char. THPC has proved a safe, effective, and nontoxic treatment that withstands laundering and dry cleaning. First used in military combat clothing, firefighters' uniforms, hospital linens, and flame-resistant children's nightwear, flame-retardant-treated fabric is also worn by U.S. astronauts.

Widely used DEET—short for N,N,diethyl-m-toluamide—repels deer ticks, mosquitoes, chiggers, and fleas. Today, it is the active ingredient in many commercial insect repellents, including sprays, lotions, gels, creams, towelettes, and sticks. DEET protected U.S. soldiers assigned to Operation Desert Storm and to Somalia from malaria-bearing mosquitoes and other disease-carrying pests.

The molecular structure of one of the ribonucleic acids (RNAs)—the basic building block of life—was determined by ARS scientists. That research led to ways of altering genetic characteristics of living organisms by modifying the structures of nucleic acid. The identified RNA is a "transfer" RNA (tRNA) that selects and carries activated amino acids to protein-building sites within the cell. There the tRNAs align with each other along a template of other nucleic acids. The sequence of this alignment determines which protein will be synthesized. Protein synthesis is the process by which living cells convert food into new cell-building material.

Phytochrome—the physiochemical agent that regulates all aspects of plant growth, from germination to flowering to fruiting, in response to changes in sunlight—is also an ARS discovery. It has led to unprecedented progress in research on understanding how plants biosynthesize complex carbohydrates. Since photosynthesis is so fundamental to plant growth and development, it affects every major agricultural problem.

Development of near-infrared reflectance (NIR) spectroscopy allowed for rapid measurement of the protein, oil, and moisture in grain. NIR technology enabled the first spectrophotometric detection of the plant pigment phytochrome. Besides revolutionizing the grain-marketing industry, NIR technology has had far-reaching applications in food quality, insect control, nutrition, and measurement of the effect of certain biochemical changes on flower color.

Improved understanding of the nutritional needs of the elderly, infants, and other specialized groups is the work of ARS scientists. For example, they found a link between cataract development and lower levels of vitamin B6, folate, and taurine in the diets of the elderly. Cataracts are responsible for 42 percent of blindness worldwide. ARS research findings on dietary calcium and manganese showed their effects on women's menstrual cycles. ARS researchers have also shown the relationship between vitamin C intake and blood pressure in the elderly.

Lactose intolerance was also tackled by ARS scientists. They developed a treatment to make milk and milk products available to millions of people worldwide who were unable to drink them without experiencing severe abdominal discomfort. The development of lactose-modified milk, called Lactaid, has boosted milk consumption by 2 to 3 percent. The treated milk can also be used to make various milk-based products, including cheese, ice cream, and yogurt.

Super Slurper is a starch-based product ARS scientists discovered that can absorb 2,000 times its own weight in water. New and practical uses for the thirsty gel are found every year. Among these diverse applications are disposable diapers, fuel filters, sanitary napkins, bandages, and baby powder. Super Slurper can coat seeds to accelerate germination, remove water from fuels, and clean up pesticide and other chemical spills.

Taxol, the anticancer compound, is a current treatment for ovarian and breast cancer. Its potential use for a variety of other cancers, including head and neck, leukemia, lung, and lymphoma, continues via clinical trials. Taxol was first discovered in the bark and needles of the Pacific yew, an evergreen tree native to old-growth forests of the Pacific Northwest. Unfortunately, it takes several thousands of the slow-growing yew trees to produce just 1 pound of taxol. Looking for alternative sources and means of production, ARS scientists were the first to establish plant cell cultures of *Taxus*. They demonstrated that these cultures could be used as an alternative source of the drug. The leading North American company in the development of a plant cell culture process licensed the original technology from ARS for production of taxol. This ARS-based research has led to industrial interest in using plant cell culture for the production of value-added products such as pharmaceuticals, flavors, and fragrances.

The successful eradication of several animal diseases—including vesicular exanthema, Venezuelan equine encephalomyelitis, Avian influenza, sheep scabies, exotic Newcastle disease, and hog cholera—can be attributed to ARS research.—By **Hank Becker,** ARS.