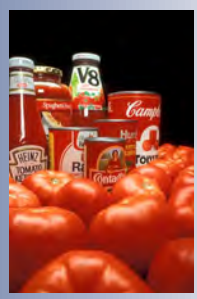
SCIENCE IN YOUR SHOPPING CART

Some of the many ways, both familiar and surprising, that agricultural research touches and improves daily life in the United States



U.S. DEPARTMENT OF AGRICULTURE • AGRICULTURAL RESEARCH SERVICE

Program Aid 1558

Revised October 2005

SCIENCE IN YOUR SHOPPING CART

Abundant, affordable, vast variety—it's the American way when it comes to groceries.

U.S. consumers have the safest, least expensive food in the world. They spend just 10 percent of their disposable income for food compared to France where they pay 15 percent and Japan where it's 26 percent. And that 10 percent for food in the United States is only half of what it was 50 years ago.

Along with the low cost of food, there are new products every year, offering more convenience, longer shelf life, better nutrition, new flavors, and sometimes even a whole new idea that no one has brought to consumers before.

This abundance comes from agriculture—farmers and ranchers who produce a bounty of food and agricultural commodities from which industry creates a virtually endless list of products for consumers. Pharmaceuticals, cosmetics, insect controls, alternative fuels, and leather, not to mention a proverbial cornucopia of fruits, vegetables, nuts, grains, meats, and fish all coming to stores near you by way of one of the greatest agriculture systems in the world.

Supporting the continuing success of U.S. agriculture is the progress that agricultural research provides—much of it from the laboratories of the Agricultural Research Service, the U.S. Department of Agriculture's chief in-house research agency.

Federally funded agricultural research is so successful in finding solutions to farmers' problems and providing what consumers need that $1.35 is returned to the taxpayer for every dollar spent on it.

Without ARS research, wheat yields would not have doubled and milk production per cow tripled in the past 50 years, you'd be paying much more for food than you do today, and your choices would be far more limited.

So widespread are ARS's crop improvements, you're very likely to be buying a product of ARS research any time you shop for produce. While many of these improvements—like extending harvest seasons, increasing growing range, and improving disease resistance and tolerance to pests—appear at first glance to benefit only the farmer and rancher, they ultimately always benefit the public by making food more affordable and more available.

Besides the traditional farming and ranching products like food and clothing, ARS research has brought you many everyday items that you might not connect with agriculture, like permanent press cotton and DEET mosquito repellents.

Agricultural research, like all science, is a continuum, a spiral that builds on its past. A scientific discovery can end up creating a new product for you to use and enjoy, which is then superseded by an improved version, which scientists then go on to improve in another way. Research never stands still. That means the examples we've given here are a snapshot of how ARS and agriculture have contributed to making your life better.

Yet, while ARS research has played an essential role in bringing you, the consumer, a virtually endless list of products, what isn't to be found on any store shelf is an Agricultural Research Service brand name.

So the next time you forage down a grocery store aisle, give some thought to all the scientific accomplishment that has gone into those products you are putting in your shopping cart.

THE WELL-POLISHED APPLE

Apples are an all-American success story—each of us eats more than 19 pounds of them annually. Thanks to fruit-breeding research, we're able to enjoy more productive, healthy, and flavorful new varieties every year. And we're collecting and preserving the world's bounty of apple genestock so the apples of tomorrow may be even sweeter, crunchier, and better than ever.

Think about the quality of the apples you buy at the supermarket: They may have been stored for as long as 9 months, but you can bet they'll remain crisp, thanks to controlled-atmosphere-storage methods devised by ARS. Never before have growers had a better chance against pests and diseases in the apple orchard, thanks to new, nonchemical biocontrols. ARS scientists have toiled to harness naturally occurring yeasts and bacteria and turn them against apples' enemies.

Fresh apple slices are now available at McDonald's, grocery stores like Traders Joe's, and in the school lunch program since ARS and Mantrose-Haeuser Co. developed a coating that prevents apples from browning. The coating increases the shelf life of peeled apples without changing the texture or flavor, allowing them to become a practical retail offering and providing a convenient healthy food option for consumers. Putting new apple options on its menu has made McDonald's the largest restaurant or food service buyer of fresh apples. NatureSeal, the trade name for the technology, is available to the general public at www.natureseal.com.

CARROTS WITH CHARACTER

Carrots haven't always been the vitamin A powerhouse they are today. Over two decades ago, ARS scientists began a quest to breed carrots packed with beta-carotene—an orange pigment used by the body to create vitamin A. Thanks largely to this ARS work, today's carrots provide consumers with 75 percent more beta-carotene than those available 25 years ago.

The researchers haven't limited themselves to the color orange. They've selectively bred a rainbow of carrots—purple, red, yellow, even white. Scientists are learning that these plant pigments perform a range of protective duties in the human body.

And carrots aren't just healthier, they're easier to eat. Thanks to our pioneering work in lightly processing foods, the freshly peeled carrots sold in the produce section are free of the white film that sometimes masks their bright orange color. Processors simply dip the peeled, ready-to-eat vegetables in a heated bath of water and citric acid for 30 seconds and then quickly dunk them into cold water. The technique is simple, fast, and inexpensive. It won't affect taste either. The heated citric acid, which is a natural product of citrus fruit, simply stops unwanted enzymes from forming.

HEALTHIER AND TASTIER TOMATOES

The tomato is a New World fruit that became an essential ingredient in many Old World cuisines. It's the main ingredient in pasta sauces, salsa, catsup, and tomato juice and a colorful addition to green salads and vegetable platters. The Roma tomato, released by ARS in 1955, is still the main variety used for tomato paste. Lately, our researchers have bred new lines of processing tomatoes that yield orange-colored fruit high in beta carotene, and they've used molecular bioengineering to produce processing tomatoes with longer shelf life and increased lycopene, the antioxidant that gives them their red color.

We're also closer to solving one of the most vexing problems of fresh-market tomatoes—the ultimate goal for farmers and consumers—developing varieties that can be left to ripen longer on the vine and still remain firm and tasty through a couple of weeks of shipping, handling, and sitting on the shelf.

A PERFECT PEACH, A PRETTY PEAR

We think of peaches as coming from Georgia. Well, they do, but not exclusively. ARS researchers at Kearneysville, West Virginia, have released varieties that reliably produce sunny, juicy peaches farther north. And southern-grown fresh peaches would probably not be available in eastern U.S. markets if ARS hadn't developed improved peach varieties as well as the Guardian rootstock.

A laboratory technique called embryo culture has proven especially helpful in creating new peach varieties. When nurtured in petri dishes, tiny embryos that could not survive in nature are cultivated into plantlets. Tended carefully in the greenhouse, the plantlets can eventually be planted outdoors in the research orchard.

Whenever possible, ARS scientists look for nonchemical, environmentally friendly solutions to the many insect and disease problems that afflict orchard crops. For example, they've developed breeding lines that are resistant to Peach Tree Short Life and a bacterial biocontrol that prevents brown rot on fruit.

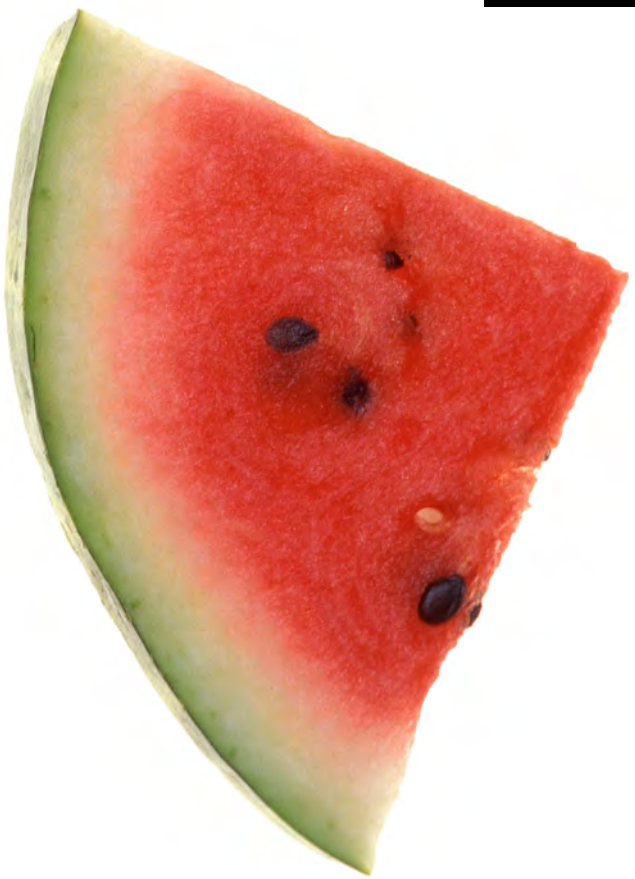
Pear research has also borne fruit. Thanks to years of pest control studies, the fire blight and pear psylla problems that long ago wiped out the U.S. East Coast pear industry have yielded to a variety of new controls. We've even come up with a computer program to help growers predict when fire blight will strike, so they can be ready for it. The program has resulted in better fire blight control and has reduced the number of sprayings that orchards receive.

DOWN-HOME PECANS

It's not a nutty idea—pecans are good for you! They contain many vitamins and minerals, and they're heart-healthy, containing 87 percent unsaturated fatty acids—62 percent monounsaturated and 25 percent polyunsaturated.

Unfortunately for pecan trees, worrisome pests and diseases keep popping up. One solution is to breed resistance into the crop. ARS's pecan-breeding program serves growers in the United States, Mexico, and other pecan-growing countries. Out of this program came Pawnee. Released in 1984, this variety is blessedly insect- and disease-resistant and produces notably large nuts of high quality as well.

SUMMER MEANS WATERMELON



There was a time, a half century ago, when good watermelons were rarely found in a grocery. Melon lovers had to grow their own, which, sadly, wouldn't keep for long.

Then, in the 1940s, along came a USDA plant breeder who set out to bring us a better watermelon. The result was "that gray melon from Charleston," formally called the "Charleston Gray." Its oblong shape and hard rind made it easy to stack and ship. Its adaptability meant it could be grown over a wide geographical area. It produced high yields and was resistant to the most serious watermelon diseases, anthracnose and fusarium wilt. Best of all, it tasted terrific! Today, there is hardly a watermelon variety grown that doesn't have a little Charleston Gray in its lineage.

On the horizon: new varieties that are low in sugar, while maintaining their high content of the antioxidant lycopene. Such low-sugar melons are a potential boon to diabetics and others managing their carbohydrates.

IT'S THE BERRIES!

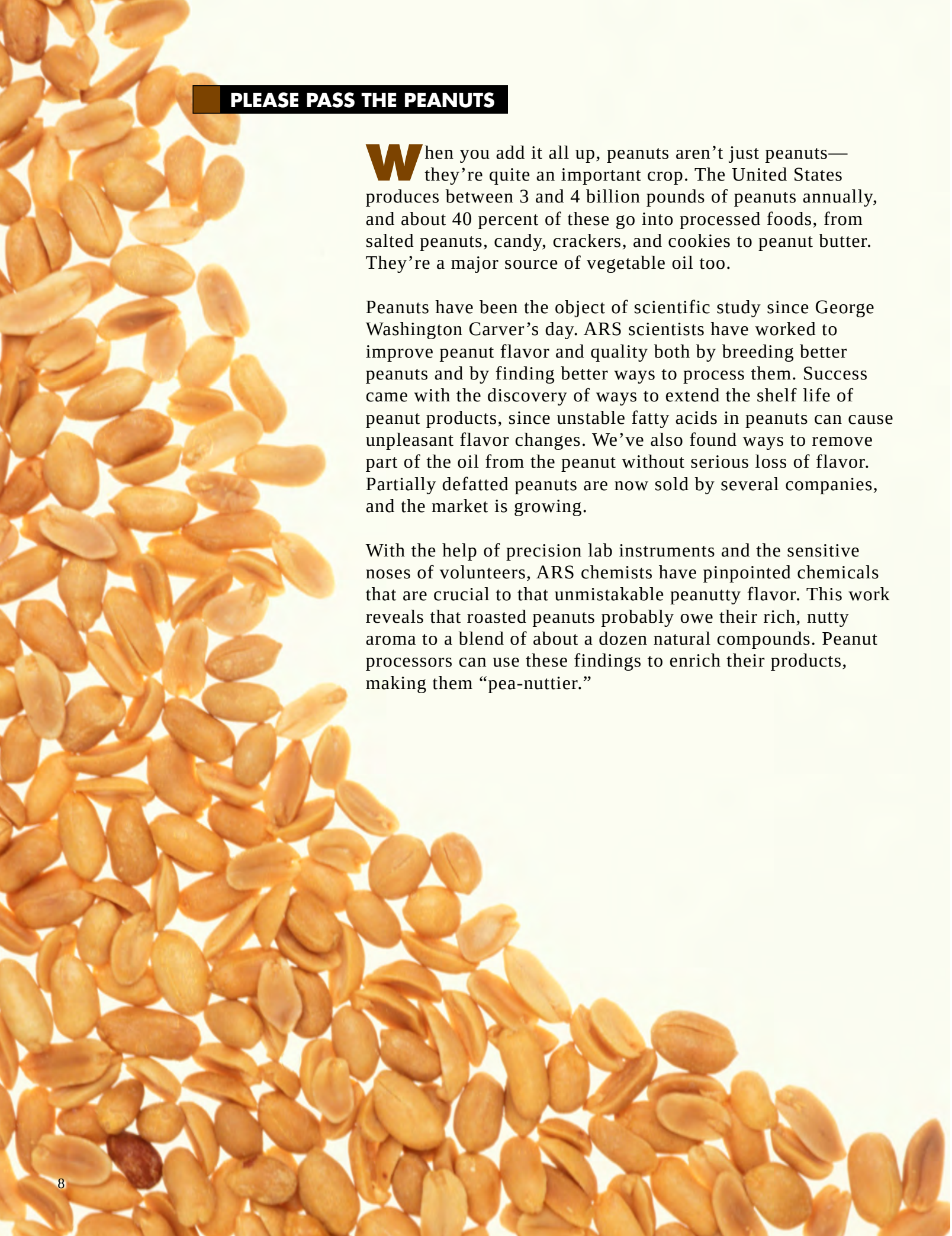
A bowl of berries is a treat for the eye as well as a delight for the palate—and packed with antioxidants, dietary fiber, and other desirable nutrients. But these tasty little morsels happen to be quite tricky to grow, harvest, and handle. These crops tend to have brief growing seasons and are vulnerable to insects, disease, and even birds, so ARS scientists have given them lots of attention.

Take strawberries. In the 1950s, ARS actually saved the strawberry industry in the Great Lakes region when we released the first varieties that could survive red stele, a root-rotting fungus. We're also old hands at strawberry breeding. ARS has helped extend the growing season, with early- and late-bearing berries that are sweet, juicy, and flavorful. This means fresh, inexpensive berries for more of the year and new market opportunities for northeastern and Mid-Atlantic strawberry growers.

Almost all blueberries and cranberries in commercial production were either developed by ARS or bred from ARS varieties. Years ago, blueberries were practically nonexistent in the Gulf States. But our early-ripening varieties have extended highbush blueberry culture to the Deep South. Today, blueberries are a small but expanding crop alternative for Dixie growers.

In the Pacific Northwest, where most of our red raspberries are grown, Willamette, a 1943 release, still accounts for 40 percent of the red raspberry acreage.

And, when USDA blackberry breeders introduced the first truly genetic thornless blackberries, Thornfree and Smoothstem, they caused a small roadside revolution. The new varieties were just what some growers needed to establish pick-your-own operations.



PLEASE PASS THE PEANUTS

When you add it all up, peanuts aren't just peanuts—they're quite an important crop. The United States produces between 3 and 4 billion pounds of peanuts annually, and about 40 percent of these go into processed foods, from salted peanuts, candy, crackers, and cookies to peanut butter. They're a major source of vegetable oil too.

Peanuts have been the object of scientific study since George Washington Carver's day. ARS scientists have worked to improve peanut flavor and quality both by breeding better peanuts and by finding better ways to process them. Success came with the discovery of ways to extend the shelf life of peanut products, since unstable fatty acids in peanuts can cause unpleasant flavor changes. We've also found ways to remove part of the oil from the peanut without serious loss of flavor. Partially defatted peanuts are now sold by several companies, and the market is growing.

With the help of precision lab instruments and the sensitive noses of volunteers, ARS chemists have pinpointed chemicals that are crucial to that unmistakable peanutty flavor. This work reveals that roasted peanuts probably owe their rich, nutty aroma to a blend of about a dozen natural compounds. Peanut processors can use these findings to enrich their products, making them "pea-nuttier."

A HOT COMBO—TORTILLAS AND CHILI PEPPERS

The hearty flavor of corn flour products like tortillas and taco shells is largely the work of a natural compound identified by ARS scientists. They have pinpointed 2-amino-acetophenone as key to flavor and aroma of yellow corn tortilla flour. Twenty taste panelists were enlisted to nose out the correct compound from a field of 30. The information can help foodmakers check the quality of their products.

Ever consider growing your own fiery cayenne pepper? We bred the Charleston hot pepper—20 times hotter than the typical cayenne, and it's ideal for growing in the home garden. One plant will produce at least 134 pepper pods, and it grows just about anywhere in the United States.

ABOUT THAT LOAF OF BREAD...

Leavened bread has been around a long while—since the days of ancient Egypt, Babylon, and Greece, in fact. Then, as now, it was made from wheat, or from a mixture of wheat and rye. The elastic gluten in wheat is essential for bread to rise.

But a lot has changed—today's bread is mass-produced. Brews of yeast, made in huge vats, are mixed continuously with flour, water, and other ingredients at one end of a machine. At the other end, dough is squished out of a tube, shaped, and cut automatically into loaves. The loaves drop into pans, rise, and are baked at the rate of thousands an hour.

Our bread also contains more ingredients and additives, which causes special problems for the baker, miller, and farmer. Even the same classes of wheat can vary significantly in baking qualities. And when these differences are great enough, they can cause a lot of trouble in a bread factory!

For 50 years, ARS laboratories have worked with all segments of the industry to help provide consumers with uniform, flavorful, nutritious bread and other wheat products. They identified and isolated wheat proteins not previously known to exist. They showed that these proteins—gliadin and glutenin—contain a specific chemical structure that affects mixing properties of flours in forming doughs They discovered the role of fatlike constituents in flour in controlling volume of bread and size of cookies. They found that certain water-soluble proteins called albumins are as essential as gluten in producing a good loaf of bread.

And over the years, ARS technologists baked thousands of loaves of bread to test different flours and to determine the effects of new additives.

Busy though scientists have been, research is accelerating. Today, with a sample no larger than half a kernel, a chemist can analyze a type of gluten protein and determine its baking properties. This can help wheat breeders get an early indication of the kind of flour their most promising plants will produce. "It provides us with an incredible amount of information," says one researcher. "And it gives it to us in a day instead of months or years."

Gluten proteins are the most abundant and most studied. Researchers already know that these proteins have a premier role in influencing a flour's quality. Scientists today are trying to uncover more details about the biochemical chores carried out by less-abundant wheat proteins that are known to be essential to a kernel's growth.

AMBER WAVES OF EVER-IMPROVING GRAIN

Across the country, ARS scientists who work with wheat aim to make U.S.-grown grain better all the time. It's not an easy job. Techniques for successfully slipping new genes into crops like tomatoes or petunias typically don't work on wheat.

But years' worth of effort have brought about many hard-won victories. A yardstick for our wheat-breeding success is the popularity of the new varieties we've come up with.

One variety alone accounts for most of the soft red winter wheat that's grown in the Eastern United States. Why? Because it stands up to wheat's most destructive disease, leaf rust.

Other varieties have amazed even dubious wheat farmers by resisting the Hessian fly and cereal leaf beetle, two costly insect pests.

And we expect more progress in the future. The wheat plants of tomorrow may be genetically tailored quickly and easily to yield more nutritious flour or more effectively fend off insects and disease, now that ARS scientists have found shortcuts for shuttling new genes into wheat embryos.

Growers can increase their expertise, thanks to an ARS-developed computer program called MoreCrop. At the touch of a few buttons, a grower can get customized advice on diseases to watch out for and treatments that are appropriate to specific conditions.

THE GREAT SAN FRANCISCO SOURDOUGH CAPER

Bakers in the Bay Area insisted their sourdough bread couldn't be duplicated farther than 50 miles from the center of San Francisco. Didn't know why, either. It just couldn't.

Enter ARS researchers, who knew there was a scientific answer to the mystery of sourdough bread. They started looking for clues.

One puzzling thing about the bread was its high acetic acid content, which contributed to its tangy taste. Yeasts generally can't tolerate acetic acid.

Obtaining samples of starter doughs from five local bakeries, a scientist found in all five a bacterium never before discovered. Naming it *Lactobacillus sanfrancisco*, he spent several months and tried 30 different substances before finding a medium in which it would grow.

The other thing he found was an unusually acid-tolerant yeast, *Saccharomyces exiquus.* It worked with the bacterium in a symbiotic relationship to produce the bread's unusual flavor, crust, and texture. Comments the scientist: "It was a happy marriage between two noncompetitive bugs."

So now San Francisco-style sourdough bread can be baked anywhere in the world. Which turned out not to be bad news for the City by the Bay. Pure cultures of *L. sanfrancisco* are now grown commercially and are commonly used by San Francisco bakers to control the quality of their product.

FROZEN FOOD THAT'S FREEZER FRIENDLY

Today's tasty, convenient frozen foods result largely from pioneering research conducted in the 1940s through the mid-1960s by ARS chemists, engineers, and other specialists. The 17-year project—what became known as the Time-Temperature Tolerance Studies—has been honored as a National Historic Chemical Landmark by the American Chemical Society.

Not every fruit or vegetable responds to freezing well—strawberries and green beans, for example. Juices leak from thawed strawberry cells, and green beans lose texture. ARS researchers found that rapid freezing of berries and beans with liquid nitrogen resulted in much more satisfactory products.

Many processed foods also resist freezing. Back in the '50s, the first TV dinners were praised for their quick preparation time but often went uneaten because of their curdled gravies and sauces. ARS to the rescue! We substituted a flour made from waxy, or glutinous, rice for wheat flour to thicken the gravies. Sure enough, gravies stayed smooth after freezing. The same trick worked on frozen puddings, replacing the traditional cornstarch thickener.

SUNBUTTER FROM SUNFLOWERS

Want something different? Try sunbutter. We've developed a process for making sunflower butter that resembles the flavor, texture, and nutty appearance of commercially available peanut butter. The technology will increase the value of sunflower seeds. Sunbutter has been introduced in various grocery food chains, health food stores, discount wholesalers, and school lunch programs. It comes in creamy, honey crunch, and low-carb, high-fiber versions.

RICHER BABY FORMULA

When you need to feed a baby formula, you can now use one that's closer to breast milk. A new, FDA-approved, baby formula that came on the market in 2002 was the first to contain DHA and ARA, two omega-3 fatty acids also found in human breast milk. The method used to process an oil rich in these essential fatty acids from natural sources resulted from a collaboration between an ARS scientist and a small entrepreneurial company. Studies have shown that babies fed infant formula supplemented with DHA and ARA perform better on mental and visual acuity tests than babies fed formula without these supplements.

MORE AND BETTER CITRUS

More than 80 percent of the citrus grown in the United States are rootstock or fruit varieties developed by ARS. In Florida, we've come up with citrus varieties that are higher yielding with increased disease resistance, better color, and longer shelf life. When you buy a sweet red grapefruit, chances are pretty good that it will be a Flame grapefruit from ARS. Most early-season tangerines—about $100 million annual retail product—are ARS varieties Sunburst and Fallglo.

Orange sections can now be prepeeled by a patented ARS process that uses commercially available food-grade enzymes. The process also removes the bitter white portion of grapefruit peel, eliminating hand-peeling and allowing more precise portion control. Peeled and chilled citrus fruits have a longer shelf life than unpeeled fruit, allowing them to be dispensed in individual sealed plastic containers in vending machines in such places as schools and health clubs.

Citrus fruits are well-known for their nutritional benefits. Lemons, limes, tangerines, tangelos, and especially oranges are high in vitamin C. Another class of citrus components, limonoids, has been shown to help fight various forms of cancer. ARS scientists were the first to show that every time we bite into a citrus slice or drink a glass of orange juice, we can readily access a limonoid called "limonin." Now we're taking a closer look at other possible health benefits of limonin.

TURNING ON THE JUICE

Sixty years ago, frozen orange juice was just a flavorless commercial flop. The only orange juice you could get back then was either squeezed from fresh oranges, mixed from a relatively tasteless concentrate, or poured from a can—and it tasted like can!

All this at a time when lots of good Florida oranges were going to waste.

Then, in 1948, Louis G. MacDowell, director of research for the Florida Citrus Commission, had an idea. He suggested that adding a little single-strength fresh juice, or "cut-back," to slightly overconcentrated orange juice might restore the flavor and aroma lost during vacuum evaporation.

He took the idea to USDA researchers, the folks with the equipment and expertise to help develop the idea. Not only did it work, but the vastly improved concentrate could be easily frozen. And so began the success story that's now such a familiar sight on the breakfast table—frozen concentrated orange juice.

And that's just the opening chapter of continuing research on achieving that fresh-squeezed taste. Nowadays, processors capture and blend the flavor compounds—well over 40 of them—that are lost during evaporation and sell them to juice-processing companies as flavor packs. Our researchers are helping develop higher quality flavor packs that more closely mimic fresh orange juice.

Making less-expensive juice with fresh-squeezed flavor would improve the desirability of U.S.-processed orange juice and help it compete in the global marketplace.

AH! SWEET MYSTERIES OF CHEESE

A long-standing mystery about the molecular structure of casein—the main protein group in milk—was solved by ARS scientists. They learned that at the molecular level, casein is truly unique. Its structure is very loose, and it contains at least 10 times as much water as any other protein. This information has helped cheese producers develop more effective and reliable processing methods and is a foundation for further research aimed at creating high-value dairy products.

We're now examining characteristics of ethnic cheeses such as the Hispanic varieties made with raw milk. Some American companies are producing Hispanic-style cheeses from pasteurized milk (a U.S. requirement for cheeses aged less than 60 days), but these don't exhibit the full range of properties of authentic Hispanic cheeses.

Imagine an all-natural mozzarella cheese that contains less than 10 percent fat—that's less than half the 23 percent in full-fat mozzarella! Our innovative cheese technology gives superior melting quality and texture to commercial reduced-fat mozzarella cheeses. This low-fat mozzarella is now used in the USDA National School Lunch Program.

SWEET CREAM FOR BUTTER

Back in the 1920s, ARS solved the problem of how to give butter a longer kitchen shelf life by making it with sweet cream in place of the traditional use of sour ripened cream. This led to a major improvement in butter production and the butter people buy, an improvement still in use today.

LACTOSE-FREE DAIRY PRODUCTS

Tens of millions of Americans are lactose-intolerant and can't enjoy many dairy products. But ARS used a bacterium to produce an enzyme that breaks down the milk sugar responsible for the problem. Today, consumers have access to lactose-free products like milk, cheese, and ice cream as well as Lactaid tablets, which let lactose-sensitive people eat dairy products.

MAKING MORE MILK

Because much of the cost of a cow is the feed and labor needed to maintain her, fewer but higher yielding cows mean lower priced milk. Dairy herd improvement ultimately benefits consumers.

That's why it's just as important to keep complete and accurate records as it is to keep the cows contented. The National Cooperative Dairy Herd Improvement Program has been tracking Bossy's milk yields since 1905.

Over the years, this program has made enormous contributions to dairy cattle breeding. ARS scientists receive the lactation records of all herds enrolled in the program and use the figures to rank the bulls that sire the Nation's dairy cows and to rank the cows themselves.

The results of years and years of scientific dairying? During the first 10 years, average yearly milk production per cow increased from 5,354 to 6,637 pounds. Today, total milk production of cows has increased more than fourfold from this program and has tripled in the last 50 years.

BUNCHES OF GRAPES

Sweet, juicy grapes, picked at the peak of ripeness, are one of nature's best-tasting treats. In vineyards, greenhouses, and laboratories, ARS scientists seek to bring even better grapes to your shopping cart tomorrow.

Red seedless grapes were all but unknown to the U.S. consumer before ARS released the Flame variety in 1973. Release of another ARS variety, Crimson, in 1989 further increased this table grape's popularity. These two varieties alone, now grown extensively by both domestic and foreign producers, make up a major part of today's consumer market.

Dark-skinned grapes contain resveratrol, an antioxidant compound that not only protects the grapes from fungal diseases, but also reduces risk of cardiovascular disease and shows anticancer activity in humans. Our researchers are probing grapes and berries to learn more about their health-related properties.

Two ARS gene banks, in Geneva, New York, and Parlier, California, are living treasure troves of grape varieties, so we expect more juicy developments ahead.

Of course, all grapes need to be properly handled. ARS studies of packaging have shown that boxes with a shrink-wrap covering offer the best insurance against loss to disease, weight loss, and shatter (grapes' tendency to drop off the stem). Plastic dome-lid boxes with vent holes are also protective. Net bags, for years considered the preferred packaging, proved the least safeguard of all.

POTATO A-PEEL

Yes, Americans do love their spuds! We each eat about 140 pounds of them a year in fresh and processed forms. Research has brought forth a slew of new, improved potato varieties for both uses.

Take, for example, Atlantic—it makes potato chips with lower fat content than any other variety, thanks to its low ratio of water-to-solid-tissue. Atlantic is now the Nation's number one chipping potato.

Are you one of the millions of Americans who never peels potatoes? Then perhaps you rely on our instant potato flakes. We invented the process in 1954 to help use up surplus potatoes. Our instant flakes were an instant hit and a big improvement over earlier powdered potatoes.

We've bred a new potato variety called Defender, which is the first processing potato variety released in the United States with both foliar and tuber resistance to late blight, including resistance to the newer isolates of the fungus. Late blight, a devastating disease of potato that caused the Irish potato famine, requires multiple applications of fungicides during the growing season for control. Fungicide costs can range from $100 to $150 per acre. Studies have shown that Defender's late blight resistance can significantly reduce or eliminate the need for fungicides.

RICE IS NICE

Cultivated rice, a billion-dollar-a-year crop, is grown in only six States: Arkansas, California, Louisiana, Texas, Mississippi, and Missouri. Long-grain rice, an American favorite, is raised chiefly in the South, medium and short-grain rice mainly in California. And everywhere that rice is grown, ARS research stands behind the crop.

Much of this work involves breeding better rice. More than half the rice grown in the United States comes from ARS-developed varieties. The high quality of this rice helps explain why 1 of every 5 bushels on the world market is grown by U.S. farmers.

For the expanding Asian market, both here and abroad, we've worked on a long-grain rice that smells of jasmine as it cooks. Jasmine 85 was originally bred in the Philippines, but ARS scientists developed the methods for growing similar rice in Texas.

Science has doubled the shelf-life of brown rice—from 6 months to at least 1 year. And researchers have found a way to make yeast-leavened bread from rice flour, a boon for people who are allergic to wheat protein. Taste panels report it is almost indistinguishable from bread containing wheat flour.

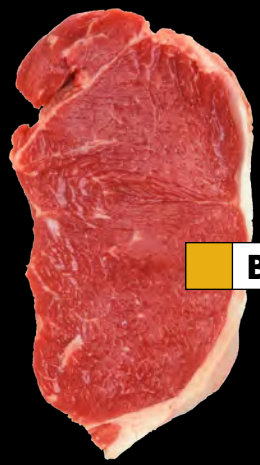
Searching for a healthier batter that absorbs less fat during frying, ARS researchers found that batters made with long-grain rice flour and small amounts of other specially modified rice ingredients absorbed about 55 percent less oil than the traditional wheat batter. Rice flour has unique properties that resist oil absorption.

POULTRY

Americans today are eating about 18 pounds of turkey apiece each year, more than double the rate 30 years ago. And virtually all those commercial turkeys owe part of their genetics to the Beltsville Small White, a small turkey bred to have lots of white meat.

Not only are turkeys themselves improved, but rearing turkeys has become a lot easier for producers, thanks to scientific innovation. The Beltsville Poultry Semen Extender enables poultry producers to set up turkey stud farms with only the best males, thus making the most efficient use of artificial insemination.

Keeping dangerous microorganisms out of poultry is a long-standing ARS research goal. In the course of this research, we made history with the first Federal cooperative research and development agreement with industry. Teaming up with Embrex, Inc., of North Carolina, we learned how to vaccinate hatching eggs against coccidiosis, a chicken disease that costs producers about $300 million annually. Since then, we've developed a similar method for injecting "good" bacteria into incubating eggs to combat *Salmonella*, thus reducing costs to producers and improving quality and safety for consumers.



BETTER BEEF

You might have a hard time finding top-quality beef at the supermarket if it weren't for all the behind-the-scenes attention that beef cattle receive. An unprotected herd can be hit hard by unseen hordes of bacteria and viruses. Brucellosis, shipping fever, bovine tuberculosis, and BSE (bovine spongiform encephalopathy) are just a few of the diseases our scientists have been working on. ARS animal research has resulted in many, many new animal medicines and programs to prevent disease transmission, and the battle against disease continues to be high-priority work.

The first draft of the bovine genome sequence has been deposited into free public databases for use by biomedical and agricultural researchers around the globe, as a result of a massive ARS project. The potential benefits from this effort may include the ability to sort cattle based on their genetic potential to satisfy consumers' desires for healthful, tender, and flavorful beef; vaccines formulated to work more effectively; and the ability to identify bulls that carry genes for desirable traits such as production efficiency, healthfulness, and palatability. The comparison between the genome sequences of various species also has potential benefits for human health in terms of developing a better understanding of the genetic nature of obesity and disease.

PROCESSED MEATS

Whether your sandwich contains bologna or corned beef, you want it to be at its most flavorful. ARS has looked at the source of flavor differences in beef, pork, lamb, and veal to find out what happens when it's aged in storage. They found, for example, that Lebanon bologna—a traditional Pennsylvania Dutch product—gets its distinctive flavor not from use of old barrels, as thought. It comes from the amount of salt used in aging the meat.

An ARS scientist changed the way that fermented meats like pepperoni and Genoa salami are made. He found that a bacterial starter stimulates faster, more consistent fermentation than traditional methods and guarantees a better product.

Other researchers turned their attention to lower-salt franks and corned beef. They reported that just about all processed meats can be made with 20 to 25 percent less salt with no risk of spoilage. Proper refrigeration, it turns out, is more important than salt level in retarding the growth of microorganisms that cause spoilage.

SAFER HAMBURGER

Consumers now have access to irradiated hamburger completely free of *Escherica coli* O157:H7, bacteria that can cause serious, even life-threatening illness. Ground beef is especially vulnerable because more than just the surface of the meat may have been exposed to bacterial contamination. Thanks in part to ARS research, irradiation of red meat was approved by the Food and Drug Administration and USDA's Food Safety and Inspection Service in February 2000. Treated meat in no way becomes radioactive.

FARM-GROWN CATFISH

Long regarded in the South as a down-home delicacy, catfish were hard to find in supermarkets elsewhere until recently. But now, thanks to aquaculture, pond-raised catfish are a popular item in the frozen food case. ARS helped scale up fish farming by breeding fish for disease resistance, finding better feeds, and eliminating chemicals and pondwater contaminants that contribute to off-flavors.

Now ARS is developing a fast, simple field test to distinguish native U.S. channel catfish fillets from fillets of other species of fish, especially basa and tra, fish that are imported from Southeast Asia. Basa and tra are often incorrectly labeled as catfish at wholesaler and retail stores. Catfish production is the largest sector of the U.S. aquaculture industry, with farm-level sales of more than $425 million and an economic impact of more than $1 billion a year.

NATURAL FAT REPLACERS

Z-Trim is a next-generation zero-calorie fat replacer from ARS labs. It can be used to cut fat and increase fiber in foods. It's made from a variety of low-cost high-fiber agricultural products such as corn hulls and bran. When processed, Z-Trim absorbs large amounts of water to provide a gelatin-like product for use in foods as a substitute for fat without adding calories, while preserving good "mouth feel." It can be used in hamburger, deli meats, cheeses, and many baked foods. It has been available to food-processing companies, and now a salad dressing-size bottle of Z-Trim allows consumers to make their own substitution in recipes.

Z-Trim is just one in a line of healthy fat replacers, which also includes Oatrim and Nutrim, developed by ARS. Oatrim, made from enzyme-treated oats and barley, has been formulated into many low-fat foods because it has only about 10 percent of the calories as fat and can lower cholesterol and mitigate blood-sugar levels. Among the companies that have licensed oatrim is Quaker Oats, Inc., which uses Oatrim in some Healthy Choice dinners.

Nutrim, also made from oat and barley grains, contains beta glucan and is beneficial as a substitute for saturated fats in food. It contributes to lower total blood cholesterol levels and weight reduction, adds a beneficial insulin and glucagon response for diabetics, and contributes antioxidant benefits.

SUGAR

U.S. sugarcane growers agree their success can be traced in large part to ARS sugarcane research and variety programs.

We've developed high-yielding sugarcanes, most armed with resistance to diseases like sugarcane mosaic virus, eye spot, smut, rust, ratoon stunting, leaf scald, and the like. And some varieties have been bred to fend off insects.

Over the years, we've helped the sugarcane processing industry with many needs, including better cane yields per acre and juice with a high sugar content. We've proved to growers that fresh cane, delivered to mills immediately after harvest, yields more recoverable sugar than cane left lying in fields after cutting.

We developed two processes for making specialized sugars for the candy industry. One, turbinado sugar, was made directly from cane juice during harvest without refinement. The other produced sugar whiter and purer than turbinado. It proved perfect for pale-colored candies like mints.

We've also improved the process of making sugar from beets, cutting sugar losses from 3 pounds per ton to 0.6 pounds.

HONEY

After analyzing hundreds of samples, ARS researchers wrote the definitive report on the composition and properties of honeys. These findings made it possible to detect the addition of other substances to honey. A side benefit was discovery of a new sugar in honey, which was named erlose, after ARS's Eastern Regional Research Laboratory.

MAPLE SYRUP

American Indians taught the early settlers how to make maple syrup, and for many years, that was that. But beginning in 1948, ARS research modernized every aspect of the process:

- Instead of collecting sap in buckets, lines of plastic tubing were installed, leading to central collection points.
- Germicidal pellets controlled growth of microbes at the taphole, extending the sapflow season and producing larger yields.
- Precision instruments controlled evaporation more carefully. Sanitation in evaporator houses was improved.
- Processing was improved to produce a syrup free of caramel and other off-flavors.

DO YOU KNOW A SOYBEAN WHEN YOU EAT IT • WEAR IT • READ IT?

Soybeans have found their way into an eye-opening array of foods. Starting with the basics, there's soy milk, used in infant formulas. And the familiar Oriental staple tofu, soybean curd, is made by coagulating soy milk. But also consider soy yogurt, soyburgers, soy loaf, and soy sausage.

Soy oil is the most widely used edible oil in the United States; you'll find it in mayonnaise, salad dressing, process cheese products, dessert frostings, and much more. Soy components such as protein and oil are ingredients in dozens of everyday foods—from the granola bar you eat for breakfast and the potato chips at lunch, to a late-night sandwich. And, attention chocoholics! You'll be hard put to find a chocolate treat that lacks soy lecithin.

Most soybean varieties have the Agricultural Research Service in their pedigree. And many soybean products have emerged from ARS labs. These range from your morning newspaper printed with soy oil-based printer's ink to lipstick, plastics, flooring, paints, and stain-removing cleaners. Then there's SoyScreen, an all-natural sunscreen.

We're also developing the first hypoallergenic soybeans, though more research is needed before they're ready for farmers and consumers, and giant vegetable soybeans for niche and export markets.

And our researchers improved the ability of biodiesel fuels, often soybean-based, to start up engines in cold weather, making them a more practical alternative to petroleum-based fuels.

TRACKING OUR NUTRITION

How much vitamin A should a 15-year-old boy get? Does a 52-year-old man need the same amount of protein as a 60-year-old woman? A 25-year-old woman? Will fish-oil supplements help lower cholesterol levels? These are some of the questions that ARS nutrition scientists must address.

They do the background research for those familiar RDAs (recommended dietary allowances), the newer DRIs (Dietary Reference Intakes), and the rainbow-colored MyPyramid food guidance system. ARS is home of the national food consumption surveys that find out what people are actually eating and maintains the USDA National Nutrient Database for Standard Reference, which lists dozens of nutrients for about 7,000 foods.

MyPyramid.gov

STEPS TO A HEALTHIER YOU

BEYOND VITAMINS AND MINERALS

During the 20th century, nutrition researchers greatly increased our understanding of the role of specific food components, especially vitamins and minerals, in our diets. While our research on vitamins and minerals continues, we've expanded our studies to include other compounds—phytonutrients—in plant-based foods that potentially help people live healthier, longer lives.

We've found, for instance, that as little as one-half teaspoon of cinnamon per day can improve risk factors for diabetes and cardiovascular diseases by 10 to 30 percent within 40 days, and some of the benefits remained even 20 days after cinnamon consumption had stopped. But table cinnamon contains fat-soluble compounds that may accumulate in the body if ingested consistently as more than a spice over long periods. ARS and university scientists have isolated the beneficial compounds, which are soluble in water, and we are working with industry to further develop the technology.

And we've been investigating phytonutrients in nonherbal tea, *Camellia sinensis*, to scientifically confirm traditional notions that tea is healthy. Tea is high in flavonoids—the same class of compounds that give many fruits and vegetables their antioxidant boost. Black, green, and oolong teas are different stages of processing from the same plant, and our ongoing studies are suggesting that they have different nutritional benefits.

MAKING FOOD EVEN SAFER TO EAT

According to the Centers for Disease Control and Prevention, each year there are about 76 million cases of foodborne illness in the United States. While most of these cases are mild, 325,000 hospitalizations and 5,000 deaths related to foodborne diseases occur annually.

ARS scientists have developed a package of computer models into a Pathogen Modeling Program that is used by food industries, researchers, and risk assessors to predict the growth of pathogens in foods under various environmental conditions. The program also allows modeling of the effect of various interventions, such as cooking and food irradiation, on pathogenic bacteria.

More than 40 models are now available for 10 pathogens, including *Salmonella, Listeria,* and *E. coli.* PMP is a key source of models used by nearly 50 percent of U.S. food-processing companies, reducing production costs and risk of foodborne disease.

COTTON: BATTING A THOUSAND

Cotton shoppers find it in the socks and underwear section, not to mention where cloth diapers and first-aid products are sold. And why not? It's often the fabric of choice, and it's being improved all the time.

Cotton has had its problems, though—including safety problems like flammability. It was ARS scientists who conducted the initial work on flame-retardant finishes. In 1953, a chemist came up with THPC, a compound that prevented cotton fabrics from flaring up when held in a flame—instead they formed a tough black char. Unlike many other chemicals tested for flame retardancy, THPC survived laundering and drycleaning. It was first used in military combat clothing, firemen's uniforms, and hospital linens. But in a short time, flame-resistant finishes, which underwent many improvements, were applied to children's nightwear and many other products. Still used today in an improved form, THPC has proved safe, effective, and nontoxic.

Does the thought of socks and underwear conjure up concerns about bacteria? Yes, microbes can reside and multiply in textile fabrics. But no matter—ARS researchers have developed treatments for cotton textiles with compounds containing peroxides. They resist bacteria and, as a bonus, resist fungi that cause athlete's foot.

When medics during World War II pleaded for self-clinging elastic bandages, stretch cottons were born. After the war, consumers asked us to make stretch cotton available in diapers, socks, and underwear. Within a matter of years, ARS chemists had invented three different ways to put more stretch into cotton.

After that, ARS helped unchain Americans from the ironing board. First our scientists brought forth wash-and-wear cotton shirts. Then we improved the process by which durable-press cotton fabric finish was created to pose no health risk to textile workers—our new way to cross-link cotton fibers used citric acid to do the trick. The improved process, which has been patented, keeps cotton fabrics wrinkle-free for more than 100 washings.

Today, everyone adores those zany designs that transfer onto cotton tee-shirts. But that iron-on heat transfer process, performed right before your eyes at the beach or boardwalk, wouldn't work on cotton—the transfer's disperse dye, which vaporizes when heated, has an affinity for polyester alone. Researchers have figured out a way to modify the cotton—so now your favorite cartoons and silly slogans "take" with ease.

STARCH THAT SLURPS

Starch is the main constituent of grain flours, and the most plentiful starch is cornstarch. Though most of the products from corn milling go into food and feed, billions of pounds of starch are produced every year, largely for nonfood purposes. Much of this is used in the paperboard, paper, and related industries, where starch serves both as an adhesive and a coating.

And new uses for cornstarch continue to surprise us. For example, when ARS scientists married starch to a synthetic chemical, they managed to create a product so thirsty, it could absorb hundreds of times its own weight in water. Someone called it Super Slurper, and the name stuck.

After patents were secured in 1976, Super Slurper started popping up all over the marketplace. The absorbent compound, which can slurp up to 2,000 times its weight in water, is used as an electrical conductor in batteries. You can find it in fuel filters, baby powders, and wound dressings, and it has been used in disposable diapers.

A CHANGE IN THE LEATHER

Leather-making is an ancient craft, but it's met up with some state-of-the-art technology. Electron beam radiation, we've found, can replace the salt solutions now used to kill bacterial growth—much to the benefit of the environment. Not only is brine-curing corrosive to equipment, it contributes to water pollution.

We also found a way to reduce the number of poor-quality hides that make their way into leather processing. Laser light-scattering photometry can be used to evaluate hides according to the orientation of their fibers.

It was ARS researchers who identified cockle, a seasonal flaw of sheepskin, as the work of a parasitic insect called "keds." Once they realized that keds not only lowers the value of the skin but also causes sheep to grow more slowly, sheep farmers began treating their herds to control infestations.

ITCH-FREE, MACHINE-WASHABLE WOOL

We've developed a better way to produce bleached, itch-free (biopolished), machine-washable wool suitable for use in clothing. The new process is an alternative to conventional chlorination, which isn't environmentally friendly. The military would prefer this type of wool to synthetics because it would be more comfortable and breathable and also safer because of the differences in how wool and synthetics burn.

POINSETTIA, A SEASONAL FAVORITE

Colorful poinsettias are America's favorite flower for the year-end holidays. In fact, they rank as the Nation's top-selling potted flowering plant. More than 80 million poinsettias are sold each year in this country, even though the poinsettia's traditional sales period is just 6 weeks.

That was not the case back in 1976, when ARS first began its program to improve the flower's dependability. This meant discovering the exact conditions of light and temperature the plant requires. They also performed breeding experiments that defined how color develops, and they devised precision growing methods that enabled massive cultivation.

AN AZTEC LEGACY

The poinsettia was introduced to the United States and named after Joel Robert Poinsett in 1825.

Poinsett was serving as the first U.S. ambassador to Mexico when he saw the plant growing on the hillsides of southern Mexico, where the plant is native.

The Aztec Indians prized poinsettias and considered them a symbol of purity because of their brilliant red color.

They made a reddish-purple dye from the colored "flowers," which are actually modified leaves called bracts. They also made a medicine against fevers from the latex sap of the plant.

FLOWER POWER!

Many of the ornamental and flowering trees and shrubs and herbaceous garden plants found in cities, towns, and home landscapes throughout the United States and many other countries were developed by our scientists at the U.S. National Arboretum through years of hybridization, selection, and careful evaluation. During its long history, the arboretum has released over 650 different woody and herbaceous plants to the American public through the nursery and floral industries. Each year, several new plants are made available.

Below are a fire lily, Clematis, and Star of Bethlehem.

AGRICULTURE'S GREAT GIFT TO MODERN MEDICINE

In 1941, British scientists, whose laboratory resources were overwhelmed by World War II, requested U.S. help to find a way to produce penicillin in mass quantities. The problem was given to Andrew J. Moyer and others at our lab in Peoria, Illinois, now the ARS National Center for Agricultural Utilization Research.

Work began in July 1941. By November, Moyer had succeeded in increasing the yield of penicillin by creating a better growth medium with the addition of corn steep liquor, an inexpensive byproduct of wet corn milling, and milk sugar. The team's development of deep vat techniques to grow the mold cultures, called deep fermentation, added the missing piece of the production puzzle.

Eight days after the bombing of Pearl Harbor, lab representatives met with U.S. drug companies, which agreed to attempt large-scale production of penicillin using the new methods. The combined work of many researchers, including USDA scientists, resulted in making penicillin available in mass quantities by June 6, 1944, just in time to treat Allied soldiers wounded on D-Day.

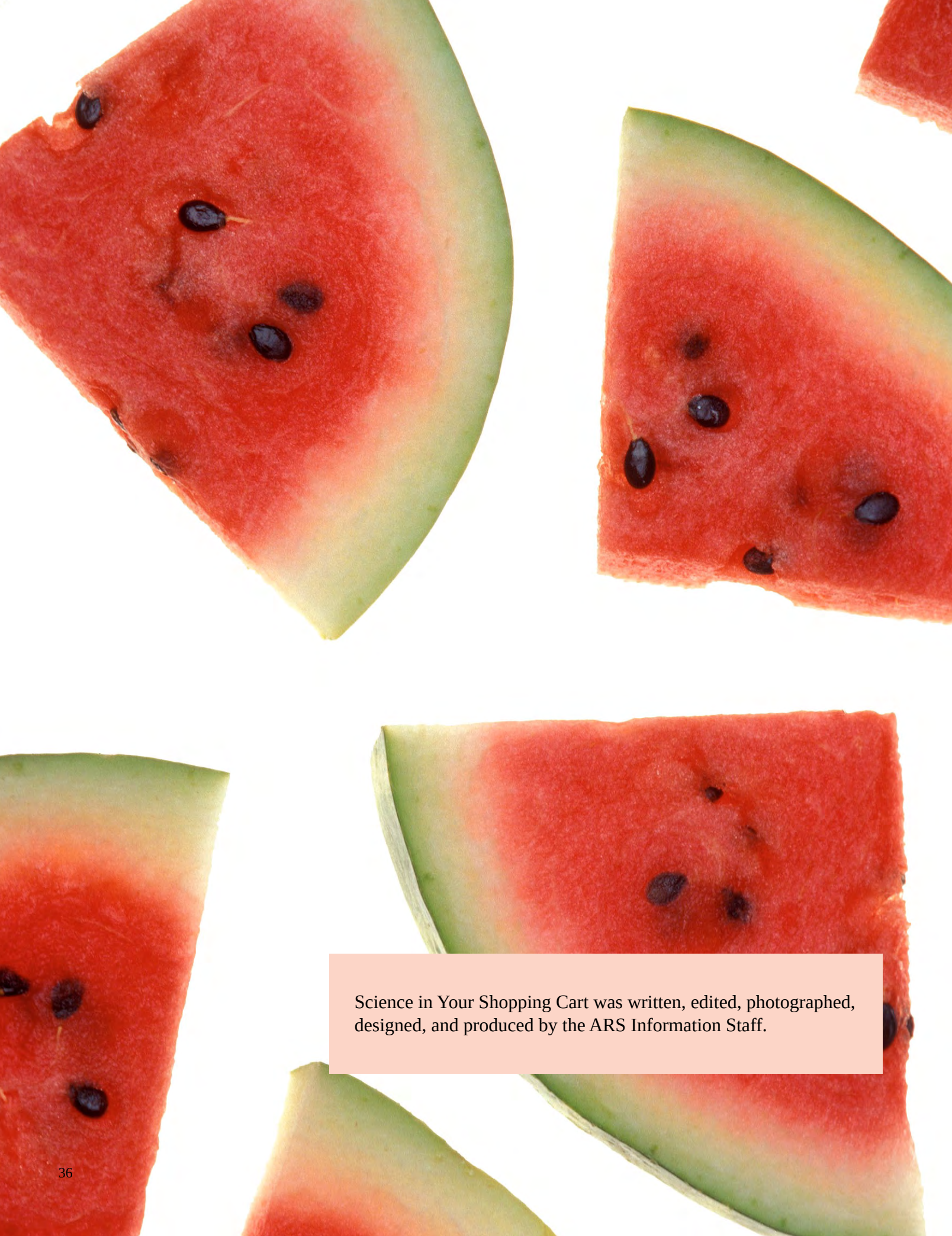
Mass-produced penicillin saved many lives during World War II and continues to do so. And the improved growth media and deep-fermentation methods and their outgrowths have since been used in development of many other important antibiotics.

In 1954, ARS developed N,N-diethyl-meta-toluamide for the Department of Defense to protect soldiers from disease-carrying insects. Now best known simply as DEET, it remains the most effective mosquito repellent available. About 230 products containing DEET are currently registered with the U.S. Environmental Protection Agency.

World Health Organization statistics report that mosquitoes spread about 4 million malaria cases, causing about 1 million deaths globally each year. These insects also spread dengue-fever-related illnesses, which lead to 24,000 deaths annually.

More recently, the spread in the United States of West Nile virus, also mosquito-borne, has focused new attention on DEET. The Centers for Disease Control and Prevention recommend that people in affected areas always wear an insect repellent containing DEET when they go outside during mosquito season as the best protection against being exposed to West Nile virus.

Some possible concerns about DEET posing a health risk have been raised. EPA has reviewed the data and determined “normal use of DEET does not present a health concern.” Several changes have been made in the label directions to ensure DEET is safely applied, mainly to avoid oversaturating skin or clothing and not to spray infants.



Science in Your Shopping Cart was written, edited, photographed, designed, and produced by the ARS Information Staff.

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AGRICULTURAL RESEARCH SERVICE