

Innovations for Reducing Food Loss and Waste



ARS researchers are finding **innovative** ways to reduce food loss and waste – from farm to table.

See how inside this report, and learn how you can help reduce food loss and waste in America.



Who is ARS?

The Agricultural Research Service (ARS) is the U.S. Department of Agriculture’s (USDA) chief scientific in-house research agency. Our job is finding solutions to agricultural problems that affect Americans every day, from field to table. ARS conducts research across the country and internationally to deliver scientific solutions to national and global agricultural challenges.

Here at ARS, we strive for scientific excellence, creativity, innovation, integrity, leadership, collaboration, accountability, transparency, diversity, respect, inclusiveness, and public service. These are our core values. These values underpin our commitment to delivering cutting-edge, scientific tools and innovative solutions for American farmers, producers, industry, and communities to support the nourishment and well-being of all people; sustain our nation’s agroecosystems and natural resources; and ensure the economic competitiveness and excellence of our agriculture.

What is ARS’s Role in Reducing Food Loss and Waste?

ARS researchers are on the forefront of finding innovative solutions to help reduce food loss and waste. While we do not receive direct funding for food loss and waste programs, we conduct research nationwide that aims to reduce food loss and waste in homes, schools, farms, and businesses, as well as converting it into value-added products such as bioplastics, biochemicals, and biobased alternatives to fossil fuels. For more information, visit the USDA Food Loss and Waste [website](#).

Please join ARS in meeting USDA’s goal to reduce food loss and waste 50% by 2030!





A Monumental Problem

Food loss and waste is a monumental problem, both in the United States and globally. Here in the United States, as much as one third of our food supply is wasted, including an estimated 31% food loss at the retail and consumer levels.

Most people don't realize how often they waste food and the negative impacts it can have for food security, the environment, and climate change. Safe and wholesome food

that is currently thrown away could help feed millions of hungry families and reduce food insecurity here and around the world. Each year, Feeding America and its network of food banks rescues around 3.6 billion pounds of food. Unfortunately, this represents only a small percentage of wholesome food that could have been donated but instead ended up in a landfill.

When food is wasted, so is the land, water, labor, energy, and other inputs that are used in producing, processing, transporting, preparing, and storing food. According to the U.S. Environmental Protection Agency, in the United States, food is the largest category of material placed in municipal landfills, where it emits methane, a powerful greenhouse gas. Municipal solid waste landfills are the third-largest source of human-related methane emissions in the United States.

And finally, food waste and loss costs money for everyone. Just looking at consumers, on average, a family of four could save more than \$3,000 a year by reducing food loss and waste!





What Can Be Done?

There are simple steps that everyone can take to reduce food loss and waste. Consumers, food producers, schools, businesses – we all have a role in this! Check out the section on pages 13-15 to learn how you can do your part.

Does the government play a role in this?

Absolutely! USDA is partnering with many local, state, and federal agencies to provide strategies and incentives to significantly reduce food loss and waste in America. The goal is to get everyone involved, from the farmers and growers to the retail stores and consumers.

Research is another critical factor for finding innovative, sustainable solutions for the food loss and waste problem. ARS has projects underway across the country designed to improve growing practices, breed fruit and vegetables that can better handle storage and transportation, find environmentally friendly alternatives to pesticides and sprays, develop new technologies to make processing and delivery more efficient, and turn post-harvest waste into usable foods and materials, including biofuels.

Take a look at the following pages as a sampling of our innovative research projects, some of which have already been introduced in the marketplace.



ARS Innovations | Preventing Food Loss & Waste

Quickly Detecting Disease in Farmed Salmon

Aquaculture, commonly known as fish farming, is a global multi-billion-dollar industry, and one of the fastest growing forms of food production. Infectious salmon anemia virus (ISAV) is a serious viral disease that affects farmed salmon both domestically and worldwide. ISAV is a highly contagious disease that can be difficult to detect. If left unchecked, cumulative mortality can sometimes exceed 90%. Detection is critical, but standard detection methods can take days to generate results, giving the disease more time to spread. ARS researchers in Orono, ME, and the University of Maine developed an improved detection method that increased testing speeds while maintaining equal if not better accuracy for ISAV detection. This improved detection tool has helped fish farmers quickly screen salmon for the presence of ISAV, reducing commercial losses valued in the hundreds of thousands of dollars. Read more [here](#).



New Strawberry “Lumina” Checks All the Boxes

Strawberries are a popular fruit for consumers, both for their taste as well as their nutritional benefits. With more than \$2 billion in annual farm gate sales and accounting for a 13% share of total production value of fruit, strawberries rank third for all fruit produced in the United States. While consumers want big, beautiful, tasty strawberries that last in the refrigerator, growers desire strawberries that fruit early in the season, are disease resistant, and have high yield. ARS researchers in Beltsville, MD, recently released ‘USDA Lumina,’ a new strawberry variety that fulfills the wants and desires for both consumers and growers. ‘USDA Lumina’ has high yield, and its large, sweet, beautiful fruits do not split open in the field or turn dark in refrigerated storage. In addition, ‘USDA Lumina’ waits to flower in the spring to avoid damage from frost but still produces fruit early in the season. For both consumers and growers, these improvements can significantly reduce food loss and waste. Read more [here](#).



ARS Innovations | Preventing Food Loss & Waste


Using Genetic Data (Genomics) to Fight A “Bitter” Disease

Pome fruits such as pears and apples are grown in the mid-Atlantic area and around the world. Growers of pome fruits often have to battle a devastating disease called Bitter rot caused by a fungus. This disease accelerates the rotting of fruits and can show up during pre and post-harvest production, causing significant food loss and waste. While Bitter rot can be controlled by fungicides, fruit that survive the growing season and enter storage often come out with Bitter rot symptoms, such as brown, sunken lesions. ARS researchers in Beltsville, MD, are using genomics to determine the genetic makeup of the Bitter rot fungi. Data can be used to design rapid screening tests, better understand the factors needed for this pathogen to cause disease, and develop novel control strategies to ensure fruit quality while reducing food loss and waste. Read more [here](#).



A bitter ending for a sweet fruit; Honeycrisp apples infected by Bitter rot.

Predicting E. coli Outbreaks in Leafy Greens

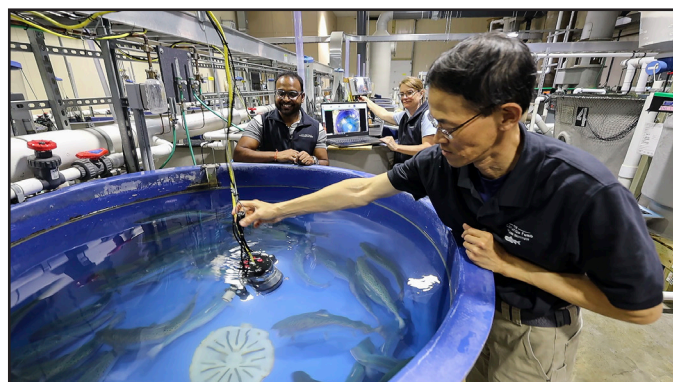


Foodborne illness outbreaks due to Escherichia coli O157:H7 (EcO157) contamination not only cause harm to consumers, but may also result in nationwide recalls for food suppliers. Leafy green producers in particular may lose a significant amount of their supply when they have to discard their products due to recalls or loss of consumer confidence after outbreaks. Predicting contamination in the field could reduce human illness and limit the amount of lettuce that must be thrown away. Researchers at ARS in Albany, CA, and Cleveland State University developed a weather data model to predict EcO157 contamination trends in lettuce. The model accurately predicted EcO157 survival rates on young romaine lettuce plants that had been measured in previous field experiments in Salinas, CA – the lettuce-growing capital of the world. Food safety regulatory agencies can use this user-friendly model to develop a weather-based risk assessment tool for the lettuce industry, thereby reducing waste due to crop contamination. Read more [here](#).

ARS Innovations | Harnessing AI and New Technologies

Using AI to Detect and Prevent Fish Mortality

Many fish farmers use Recirculating Aquaculture Systems (RAS) to rear and grow their fish. However, fish mortalities in RAS due to disease or other factors can quickly escalate, leading to disease spread and mass deaths. Fish farmers employ underwater cameras to try and detect fish disease and mortality in their RAS systems. However, camera detection can be obscured by high densities of fish as well as cloudy water. In addition, human observation and tracking of disease spread can be slow and inaccurate. ARS collaborators in Shepherdstown, WV, developed MortCam, an Artificial Intelligence- and Internet of Things (IoT)-enabled fish mortality detection and alert system. MortCam consists of an imaging sensor integrated with an edge computing device, customized for underwater applications. MortCam provides 24-hour surveillance for RAS conditions and reliably sends email and text alerts to fish farmers about mortality events. Using MortCam, farmed fish producers can apply effective and timely treatments to prevent mortality escalation, improve fish welfare, and reduce economic losses. Read more [here](#).



Researchers add the MortCam AI to an RAS system

New Tool Can Get Tomato Production Back on Track

Tomato corky root rot is a disease that can cut tomato yields in half, causing major food losses for tomato growers. This disease causing fungus is often undetected until it is too late because it attacks roots, is slow growing, and is difficult to isolate from plants. Tomato growers desperately need improved detection methods to help curb their expensive losses. ARS researchers in Wooster, OH, developed a new tool (a quantitative polymerase assay) to rapidly detect corky root rot pathogens in roots and soils. With this tool, agricultural researchers can

rapidly detect and track the pathogen, and in turn, provide farmers with strategies to better manage this disease and reduce their food losses. Read more [here](#).



Tomatoes that are stunted, yellowing, and dying from corky root rot and other soil pathogens

ARS Innovations | Harnessing AI and New Technologies

Using AI to Control Pests in Grain Production

Insects can be a real pest to grain producers, literally! Grain producers must constantly monitor pests when storing grains to ensure postharvest grain quality.

However, current sampling and monitoring methods are time-consuming, labor-intensive, and require expertise for accurate species identification. ARS scientists in Manhattan, KS, used deep learning methods and AI to develop image-based identification for five common stored grain insect species: lesser grain borer, rusty grain beetle, red flour beetle, rice weevil, and saw-toothed grain beetle.

The AI-driven system more efficiently identified all species with an accuracy level of at least 96% and enabled producers to more rapidly apply pest controls and ultimately reduce damage, food loss, and economic losses. This work is part of a broader effort to develop camera-based systems for automated pest monitoring in warehouses, flour mills, and general food storage facilities that will improve pest identification and control. Read more [here](#).



AI technology can help detect and identify insect pests in stored grains

Screening for Toxins in Our Foods Before Consumption

Aspergillus flavus is a fungus that can infect corn and other food crops before harvest and during storage. This fungus produces a toxic and potent carcinogen known as aflatoxin. Aflatoxin contamination of corn imposes a severe health risk to vulnerable populations around the world; for instance, consuming aflatoxin-contaminated crops can result in liver cancer, stunted growth in children, and death. Detecting aflatoxin contamination can not only save lives but reduce food loss and waste. ARS researchers in New Orleans, LA, and Mississippi

State University scientists developed a table-top or tablet-based, low-cost portable system that can validate aflatoxin contamination. The novel detection system costs less than \$200 and uses batteries that can be charged with solar energy, which increases its utility in remote regions. This user-friendly tool will enable small farmers and households to screen stored grains and nuts for aflatoxin contamination before the foods are cooked or consumed. Read more [here](#).



A low-cost, portable device for detecting and sorting Aflatoxin-contaminated corn kernels

ARS Innovations | Extending the Shelf Life of Food

Using Biocontrol to Reduce Potato Storage Loss

Potato losses from fungal spoilage during storage are approximately \$500 million in the U.S. The majority of losses are caused by the fungus *Fusarium sambucinum* (dry rot). There are limited chemical solutions to treat this fungus, and the fungus can become resistant to chemical treatments over time.

ARS researchers in Peoria, IL, developed an effective, environmentally friendly treatment to stem these losses, based on bacteria that are naturally antagonistic to this fungus. While effective, a major barrier to applying this “biocontrol” is formulating it as a long-lasting, dried product that is easy to apply. Researchers developed strains to be more robust to drying and created a special drying formulation in which simple, inexpensive fructose sugar is blended with the bacteria to protect the potatoes during drying. As a result, a product can be stored for over 7 months and reduce potato storage disease up to 80%. It can also work in concert with agricultural chemicals to accomplish near complete control with much reduced risk of the pathogen developing resistance. Read more [here](#).



Potatoes inoculated with biocontrol and Fusarium pathogen (left) and Fusarium pathogen only (right)

New Technology Keeps Produce Fresh, Longer

ARS researchers in Albany, CA, are developing a new technology that could “freshen up” the frozen fruit and vegetable market. The new freezing method, called isochoric freezing, works by storing foods in a sealed, rigid container – typically made of hard plastic or metal – completely filled with a liquid such as water. Unlike conventional freezing, where the food is exposed to the air and freezes solid at temperatures below 32 degrees F, isochoric freezing preserves food without turning it to solid ice. As long as

the food stays immersed in the liquid portion, it is protected from ice crystallization, which is the main threat to food quality. As an added benefit of isochoric freezing, the method kills microbial contaminants during processing. The new freezing method could not only extend the shelf life of fresh fruit and vegetable products, but also result in products that are fresh-like in taste, texture, juiciness, and nutrition. Read more [here](#).



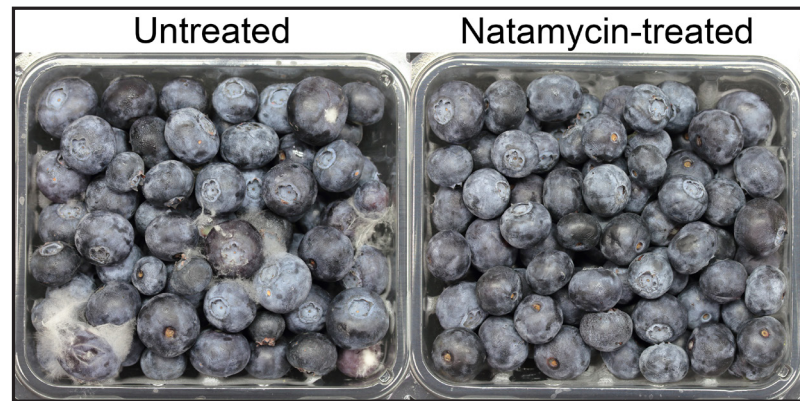
ARS researchers test new isochoric technology

ARS Innovations | Extending the Shelf Life of Food

Controlling Fruit Rots in Blueberries

Blueberries are an excellent source of essential nutrients and a good source of dietary fiber. The United States is the global leader in blueberry production, but producers are losing millions due to postharvest fruit rot diseases, which limit the storage and shelf life of fresh blueberries. Controlling postharvest fruit rot diseases is crucial to producers, both here and abroad. ARS researchers in

Parlier, CA, applied natamycin as a postharvest dipping or spraying treatment to see if it could control postharvest blueberry rots. Natamycin is a natural food additive generally regarded as safe. It's used as a preservative in foods such as yogurt, sausage, juice, and wine. Researchers determined that natamycin provided effective postharvest control for reduction of fruit rots and maintenance of fruit quality of fresh blueberries. Once it is registered, it can be used on both conventional and organic blueberries. The result is more fresh fruit for consumers and less food loss and waste at postharvest. Read more [here](#).

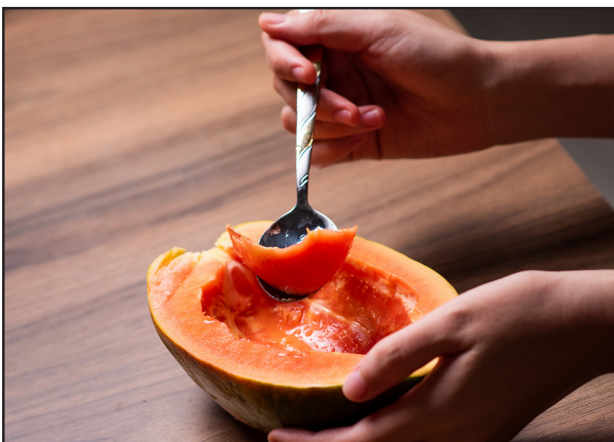


Blueberries treated with Natamycin (right) vs. untreated (left)

Extending the Shelf Life of Breadfruit and Papaya

Breadfruit and papaya are two popular fresh-market foods around the world. However, they both tend to ripen quickly and deteriorate quickly after harvest. In addition, they are highly susceptible to pathogens after harvest. These issues can lead to significant food waste by consumers and in food markets. In cooperative research, ARS scientists in Hilo, HI, and University of Hawaii researchers determined maturity indices and techniques to prolong breadfruit quality after harvest. They found

that picking breadfruit during early harvest maturity delayed discoloration, and treating the fruit postharvest with a natural ethylene inhibitor delayed breadfruit softening. Both practices have the potential to improve quality maintenance of breadfruit during transportation and storage. Researchers also determined that using a similar post-harvest treatment could extend the shelf life of 'Rainbow' papaya during commercial shipments. Read more [here](#).



ARS Innovations | Turning Ag Waste into New Uses

Squeezing More Products Out of Oranges

Worldwide, the citrus industry generates around 50-60 million tons of excess biomass when producing juices, such as orange juice, for human consumption. This underutilized biomass causes environmental issues when discarded, so finding uses for this material can reduce food waste while potentially generating new revenue streams. ARS researchers in Peoria, IL, converted vegetable oil from waste citrus seeds into biodiesel using a well-known process referred to as transesterification. The fuel properties of the biodiesel produced from waste citrus seed oil were within the specifications of the American biodiesel standard. These results are beneficial to the citrus and renewable fuels industries as well as to the public, as an agricultural waste material was used to produce an alternative fuel that facilitates the societal transition away from petroleum and its consequent environmental and climatic effects. Read more [here](#).



Finding a New Marketplace for Inshell Peanuts

Peanuts are grown for a variety of edible purposes; they can be eaten roasted, oil fried, or boiled; added to processed foods; or used for oil. In 2022, the U.S. peanut crop was estimated at 5.57 billion pounds. While peanuts are a popular product for consumers and food manufacturers, a portion of farmed peanuts are deemed unsuitable for human consumption. These nonfood grade peanuts have other potential uses, mainly for the production of oil. However, ARS researchers in

Raleigh, NC, found a new, potentially higher value application. They determined that nonfood grade inshell peanuts that are aflatoxin free could be used for livestock feed. In particular, researchers found that peanuts unsuitable for human food can be added to poultry feed without the expense of removing the shells. Adding shelled peanuts provided nutritional benefits without affecting egg laying performance or body weight. Best of all, this new source helps reduce the amount of waste from nonfood grade peanuts. Read more [here](#).



Livestock feed with (left) and without (right) added peanuts

ARS Innovations | Turning Ag Waste into New Uses

A Tasty Way to Increase Fruit Production in the U.S.

Pectin is a natural fiber found in apples, oranges, and other fruits. Pectin has many food uses, such as a binder or thickener in cooking and baking. The global pectin market is valued at over \$900 million. Most pectin is obtained from apple pomace and citrus peel when juicing those fruits. Florida is a major citrus juice producer, but there are currently no pectin production facilities in Florida, or even in the United States. To this end, ARS scientists in Fort Pierce, FL, identified optimum pilot scale conditions for pectin production from Florida sweet oranges. This work served to support the design, engineering, and commercialization efforts of a citrus juice co-product manufacturing facility in the state of Florida. Establishing a pectin production facility in Florida would allow for a domestic source of pectin, increase production value of Florida citrus, and reduce citrus waste. Read more [here](#).



A screw press shredding pectin fibers



Mushrooms grown with 100% peat moss (left) vs 50-50 peat moss and almond hulls (right)

Novel Uses for Discarded Almond Hulls

Almond shells and almond hulls are an inexpensive, abundant waste by-product from the U.S. almond-nut industry. They can be added to livestock feed and converted into sugars for biofuels, but more diverse uses are needed to reduce the excess waste. ARS scientists in Albany, CA, developed a novel application for “spent hulls,” using them as a replacement for non-sustainable

peat moss to commercially produce mushrooms. Spent almond hulls are hulls with their sugars removed and they possess important traits, such as a water-holding capacity of greater than 500 percent and high mineral content ideal for mushroom growth. ARS scientists also used a thermal process called torrefaction to produce a residue from almond shells that improves adhesion properties when added to recycled plastic while also improving recycled plastic heat stability and stiffness. ARS researchers and their industrial collaborators are exploring the use of torrefied almond shells to replace or reduce the percentage of polymers in shipping pallets. Read more [here](#).



What is Your Role?

What can I do to reduce food loss and waste?

No matter your age, where you work, where you live, or what your occupation, you can take simple steps to reduce food loss and waste. Here are some examples, with links provided to make a bigger impact on this massive global challenge.

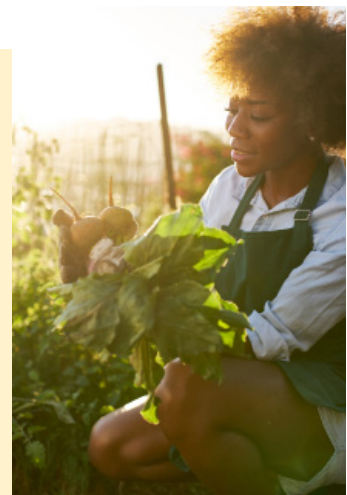


For Consumers

- Before you go to the grocery store or order online, make a list so you don't buy more than you need.
- Only put on your plate what you intend to eat. You can also go back for seconds.
- Pack leftovers in small portions in shallow containers, mark the contents and date, refrigerate, and use within 3 to 4 days or freeze immediately.
- Recycle food scraps into compost, an organic material that can be added to soil to help plants grow. Set up a home compost bin or drop your food waste at a local compost center.
- See more ideas at <https://www.usda.gov/foodlossandwaste/consumers>.

For Farmers and Growers

- Use on-farm storage to help reduce post-harvest loss.
- Invest in value-added products, such as turning berries into jams.
- Partner with a produce delivery service that accepts perfectly edible but cosmetically imperfect fruits and vegetables.
- Donate excess wholesome food to a food bank.
- See more ideas at <https://www.usda.gov/foodlossandwaste/farmers>.





What is Your Role?



For Schools

- Allow students to decline some components of a reimbursable meal as a way of providing choice and reducing waste (also called offer-versus-serve).
- Extend lunch from 20 to 30 minutes, thereby creating more time for students to finish their lunches.
- Create designated stations (share tables) where children can return whole and/or unopened food or beverage items they choose not to eat. These items are then made available to other children who may want another serving during or after the meal service.
- Allow students who did not have enough time to finish their perishable foods during lunch save them for later in the day or to take home.
- See more ideas at <https://www.usda.gov/foodlossandwaste/schools>.

For Businesses

- Consider [applying](#) to be a champion and aim to reduce your business's food loss and waste by 50% by 2030.
- Develop cost-effective solutions for reducing food loss and waste, both in operations and personnel.
- Donate excess wholesome food to a food bank.
- Provide incentives for your staff to come up with ideas for reducing food loss and waste.
- See more ideas at <https://www.usda.gov/foodlossandwaste/businesses>.





Where Can I Find Out More?



The U.S. Department of Agriculture is deeply committed to reducing food loss and waste, and we provide helpful tools and guidance as well as incentives for consumers, farmers, schools, and businesses to do their part in reducing our food footprint. If you would like to learn more about ways to reduce food loss and waste, check out the links below:

- Visit USDA's Food Loss and Waste website at <https://www.usda.gov/foodlossandwaste>
- Read the National Strategy for Reducing Food Loss and Waste and Recycling Organics here: <https://www.usda.gov/foodlossandwaste/national-strategy>
- Check out the Federal Interagency Collaboration to Reduce Food Loss and Waste here: <https://www.usda.gov/foodlossandwaste/interagency>
- See which businesses earned the title as U.S. Food Loss and Waste 2030 Champion here: <https://www.usda.gov/foodlossandwaste/champions>

For more information on USDA efforts to reduce food loss and waste in America, contact:

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USDA's Agricultural Research Service (ARS) is the premier research agency for agriculture, and while the agency does not receive direct funding for food loss and waste programs, it conducts research nationwide that aims to reduce food loss and waste in homes, schools, and businesses. For more information, visit the USDA Food Loss and Waste [website](#).

A large background image showing a pile of various food items, including apples, oranges, corn, and other produce, some of which appear to be discarded or spoiled, illustrating the concept of food loss and waste.

Innovations for Reducing Food Loss and Waste

**Thank you for your interest in reducing
food loss and waste in America.
Together, we can help reduce food
waste and loss 50% by 2030!**

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