

Transporting food from farm to table, efficiently

ASU industrial engineer studies ways to make sure produce gets from those who grow it to those who need it

By Kelly deVos, ASU News

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Arizona is the nation's winter lettuce capital, producing [approximately 90% of country's supply](#) from November to April, according to the Arizona Farm Bureau.

But before those crispy, crunchy, leafy greens can be tossed into salads and used to top sub sandwiches, they must be transported from coast to coast, arriving fresh from Portland, Oregon, to Portland, Maine.

[Deniz Berfin Karakoc](#) is an assistant professor of industrial engineering in the [School of Computing and Augmented Intelligence](#), part of the [Ira A. Fulton Schools of Engineering](#) at Arizona State University. She researches agri-food flow networks, or how agricultural products are made, stored and moved, to best connect those who produce food with those who need it.

Karakoc has co-authored a [groundbreaking paper](#) on food transportation systems that was published in the peer-reviewed journal Nature Food.

For the work, "Trade-offs between resilience, sustainability and cost in the U.S. agri-food transportation infrastructure," she collaborated with [Megan Konar](#), an associate professor of civil and environmental engineering at the University of Illinois Urbana-Champaign.

The pair of researchers have been busy looking at food transportation, analyzing routes to ensure that distribution options are well-protected, sustainable and cost-effective. Karakoc explains that the issue has been understudied.

"The U.S. is a critical part of the world's food supply chain. It is a top exporter of cereal grains," she says. "Agricultural studies tend to focus on vulnerabilities created by weather. But the ability to move food from production to consumption is vital."

From railways to waterways to highways

Karakoc studied the various U.S. systems available to transport agricultural products. The work was driven by a key question: How does the nation's transportation infrastructure support agri-food supply chains?

Her goal was to analyze the trade-off between cost, adaptability and sustainability across these transportation modes.

Cheaper transportation methods help keep food costs low, and therefore more readily accessible to people at various income levels. Resilient systems mean fresh food can be delivered as needed. Studying transportation networks also helps advance sustainable practices.

The paper reports that the carbon footprint exclusively related to transporting America's food is greater than all annual carbon emissions made by the nations of Belgium and Colombia.

Karakoc's study also found that ground transportation via U.S. highways is the most common method used to transport food. This option is one of the most resilient as there are often multiple ways to route and reroute traffic. Highways are essential to the distribution of perishable food. But highway transportation is the most expensive of the options studied — and results in the most pollution.

Moving food along waterways is the lowest-cost option but less flexible. While nearly 40% of soy products were transported along waterways, especially down the Mississippi River, not every state or region has access to such options. Karakoc and Konar also point out that critical infrastructure investments, such as restoring dams and deepening chokepoints, are needed to ensure that food can continue to effectively flow across the nation's gulfs and rivers.

Meanwhile, railway transport is highly efficient solution for moving large quantities of food across long distances. Railways are particularly essential to the movement of cereal grains. But this form of transportation is subject to natural disasters and may create more pollution than waterway options. As with waterways, the nation's rail infrastructure needs reinvestment to incorporate new and higher-capacity equipment.

Finally, the study emphasizes the urgent need to enhance refrigerated transportation systems to safeguard food from spoilage in warm weather scenarios.

Karakoc hopes the new research will better inform lawmakers and the public about the importance of strong agri-food flow networks.

"Food is essential, and we should be able to trace it from farm to fork," she says.

A 'rising star' in research

Karakoc is an emerging voice in the areas of food supply chains, infrastructure networks and geographic information sciences. She joined the Fulton Schools this fall after completing her doctoral degree in civil and environmental engineering from the University of Illinois Urbana-Champaign. She was honored as a "[rising star](#)" at an early career workshop at the Massachusetts Institute of Technology.

Today, she plays a key role in the rapid growth of the highly ranked Fulton Schools industrial engineering program.

[Ross Maciejewski](#), director of the School of Computing and Augmented Intelligence, says that Karakoc is an excellent addition to the team.

"Sustainability research at ASU has achieved world renown. Deniz brings an exciting set of skills to our industrial engineering program that ties together network analysis and operations research," he says. "I'm excited to see what collaborations she'll build here as this sort of interdisciplinary research has long been a strength within the school."

Karakoc plans to stay busy, recruiting doctoral students to help continue her work.

"The ultimate goal of my research is to provide practical, implementable strategies that make food affordable and available for everyone — at all times," she says.

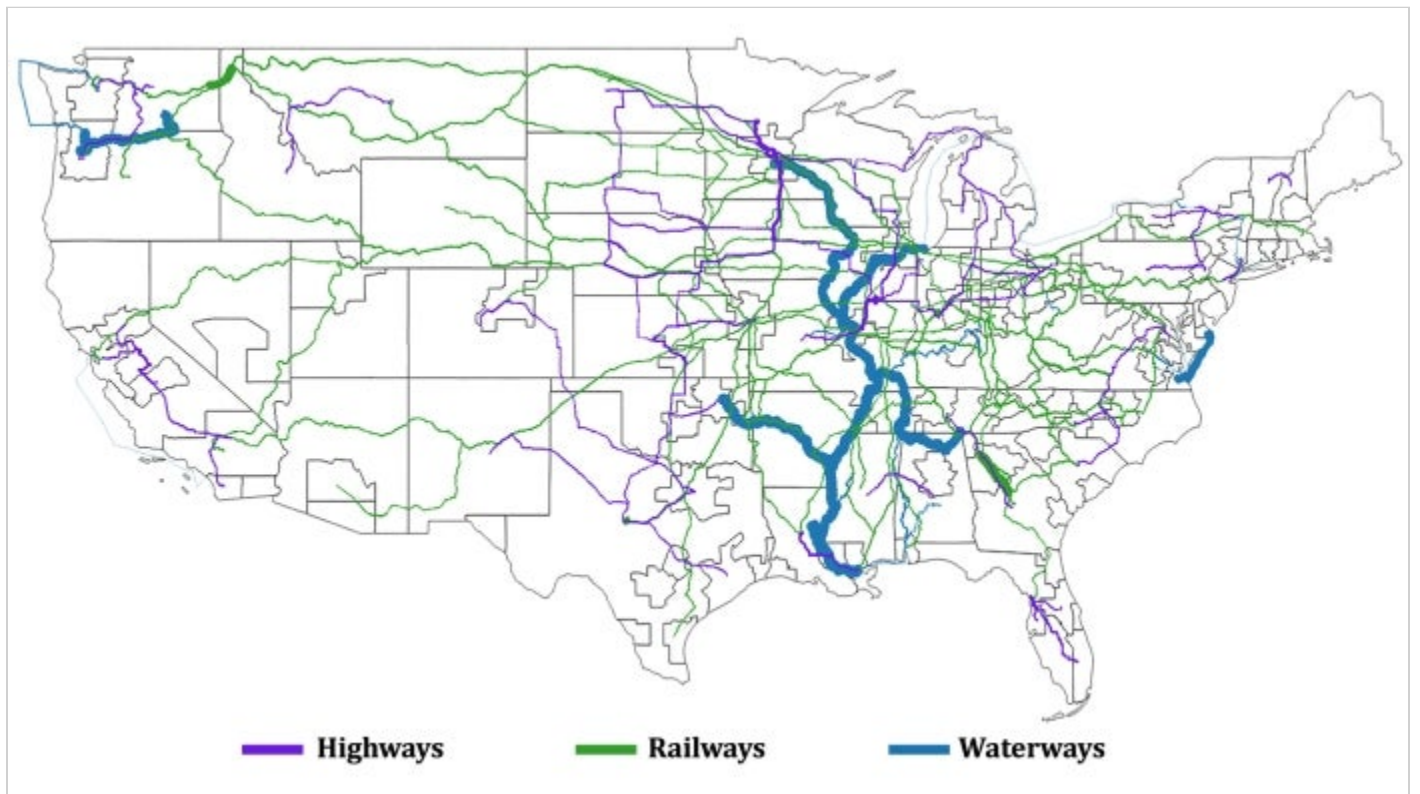
This story originally appeared on [ASU News](#).

Main image



Heads of lettuce grow in Yuma, Arizona. Farmers and foodies rely on the nation's transportation systems to put dinner on the table. Deniz Berfin Karakoc, an assistant professor of industrial engineering in the School of Computing and Augmented Intelligence, part of the Ira A. Fulton Schools of Engineering at Arizona State University, studies ways to ensure food transportation networks are resilient, cost-effective and sustainable. Photo by Erika Gronek/ASU

Text image(s)



Karakoc's work maps food movement onto the real-world transportation infrastructure. The illustration above shows top domestic food-mass movements plotted by the team. This research can help experts compare options to create resilient food flow networks. Illustration courtesy of Deniz Berfin Karakoc/ASU



Karakoc joined the School of Computing and Augmented Intelligence in the fall as part of efforts to expand the industrial engineering program. She is an emerging leader in the study of agri-food flow networks. Photo by Erika Gronek/ASU