Planting less water-intensive crops in the western United States would help alleviate water scarcity, study finds

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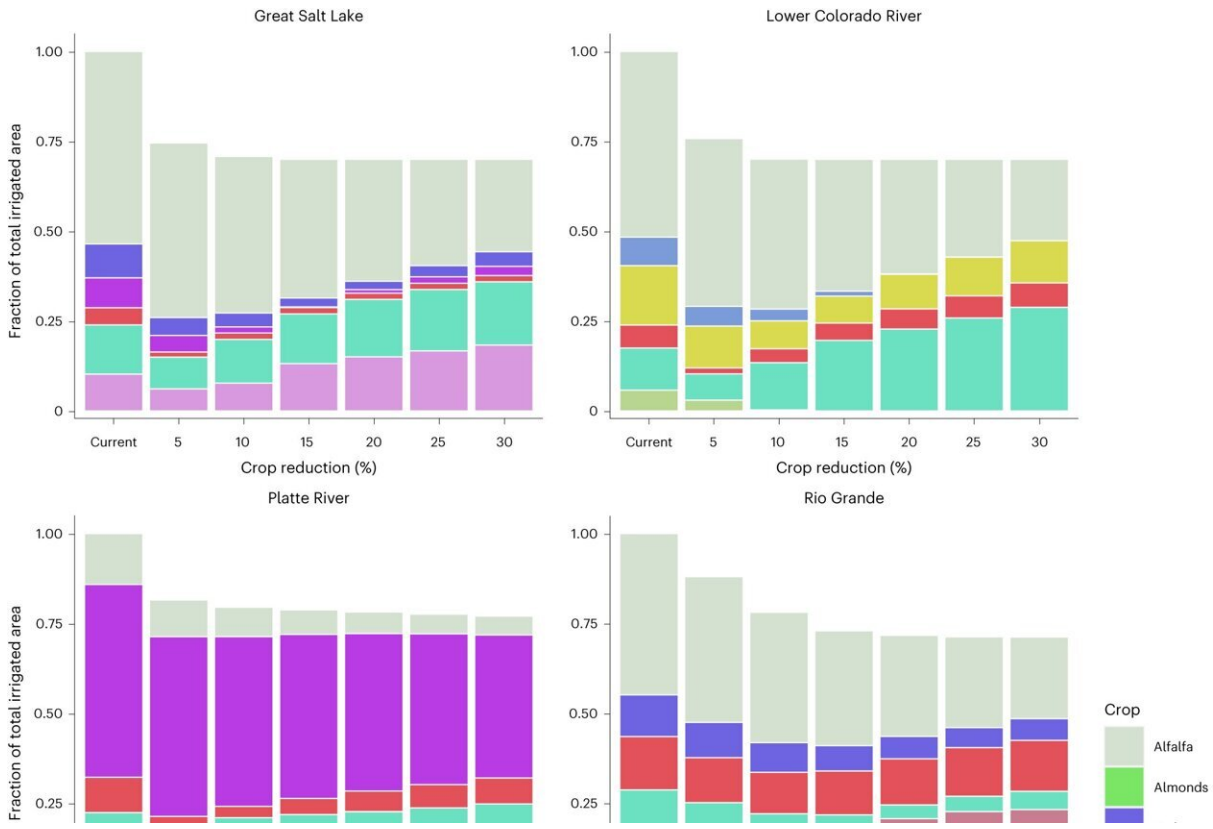

Histograms of crop mixes illustrate the crop shifting for the most prominent crops in each case study area. Alfalfa is reduced in five of the six study areas (all but San Joaquin) due to its high water consumption. All optimizations maintain or increase net farm profit in each HUC. The percentages shown on the x axis represent the extent to which any single crop can be reduced in each HUC. Credit: *Nature Water* (2023). DOI: 10.1038/s44221-023-00155-9

Across the world, irrigation dominates freshwater consumption, accounting for 88% of all the freshwater consumed on a global scale. In the western United States, this is no different, as irrigated farming is the leading driver of water depletion in the region. In addition, climate change has caused it to become increasingly difficult for the western United States to meet the water needs of farms, cities and ecosystems.

In a paper published in *Nature Water*, researchers from the University of Delaware, Sustainable Waters—a global organization focused on water scarcity challenges—and Virginia Tech looked at six agriculturally important river basins in the western U.S. that are experiencing water scarcity: the Great Salt Lake, the Lower Colorado River, the Rio Grande, Snake River, Platte River and the San Joaquin River.

They also determined which crops are currently being grown in the areas and examined how switching to less water-intensive crops would help with water scarcity while also allowing farmers to remain economically viable.

Kyle Davis, assistant professor in the Department of Geography and Spatial Sciences and the Department of Plant and Soil Sciences, as well as a resident faculty member with UD's Data Science Institute, and Dongyang Wei, a doctoral candidate in the Department of Geography and Spatial Sciences, were part of the research group from UD. The lead author on the paper was Brian Richter, president of Sustainable Waters.

Freshwater and irrigation

The mismatch of freshwater availability and the water needed for the irrigation of crops has caused river flows and aquifers to dry up at an alarming rate. In response, water regulators are now implementing or

planning mandates geared toward reducing water for agricultural use.

While these mandates are no doubt necessary and effective in the short term, there is a growing acceptance that irrigated farming cannot continue in its present state and the current mix of water-intensive crops being grown out west must change.

Wei said that in most of the areas they looked at, alfalfa and hay used to feed cattle was the crop that used the most water—not necessarily because it was the most water-intensive crop but because it is so widely planted in the west. In addition, corn and almonds used large amounts of water in the areas of the Platte River and the San Joaquin River, respectively.

While it would be unrealistic to suggest that growers simply swap out those crops with any other crop that uses less water, Wei stressed that the researchers selected only crops that have previously been planted in the areas they were studying so as to not come up with estimates that would be far off from the reality of the situation.

"The crops that we suggested to replace the current crops being grown varies from area to area," Wei said. "Also, the alternative crops to replace alfalfa are relatively less water-consumptive but they also needed to provide enough net revenue to the farmers to cover the revenue loss from the alfalfa."

Another important strategy to save water was to employ the use of fallowing, a farming technique where arable land is left without sowing for one or more vegetative cycles.

The authors found that a maximum water savings of 28% to 57% is possible across all six study areas when fallowing is integrated into a less water-intensive crop mix. However, because it may be unrealistic for the

farmers to fallow a large portion of their field, the researchers put in a modeling constraint to limit fallowing to only between five and 30% of the total area of a farm.

To conduct the study, Davis said the researchers used agricultural statistics to estimate farmer profitability for different crops and different places. The actual amount of water that each crop consumes was estimated using a crop-water model where the researchers input climate and soil data and looked at how much water the crop requires in order to grow without stress.

"Once you know how much water a crop needs and how extensively that crop has grown, you can estimate the total volume of water that that crop requires in a particular place," Davis said. "We input these volumes into a national hydrological model that estimates how much water is consumed in each sub-basin across the U.S. and then passes that remaining water downstream to the subsequent sub-basins so you can see how the depletion propagates along the entire river basin."

Davis said the hope is that with this study, policymakers can see a possible promising solution to help solve the water crisis out west.

"With issues like climate change and extensive droughts happening, it's even more of a pressing issue to reduce water demand so that different human and ecological activities can continue to take place," Davis said. "This is our way of putting an alternative suggestion out there to what has already been considered as a way that can substantially save a lot of water."

They also see their findings contributing to conversations with water managers, state and federal governments, and farmers about what can work on the ground if these types of solutions are to be implemented.

In future research, they hope to carry out large-scale experiments where they pay farmers to implement the different crops and measure the outcomes hydrologically. This will help to give them a better way to evaluate the co-benefits of implementing these solutions in different aspects of society.

"These types of studies assess a variety of different outcomes in parallel that are important to different water users," said Davis. "I think that trying to identify solutions that take all those different considerations into account is really important and can make it more likely that the information and findings that we generate will help to actually realize positive change."

More information: Brian D. Richter et al, Alleviating water scarcity by optimizing crop mixes, *Nature Water* (2023). DOI: 10.1038/s44221-023-00155-9

Provided by University of Delaware

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