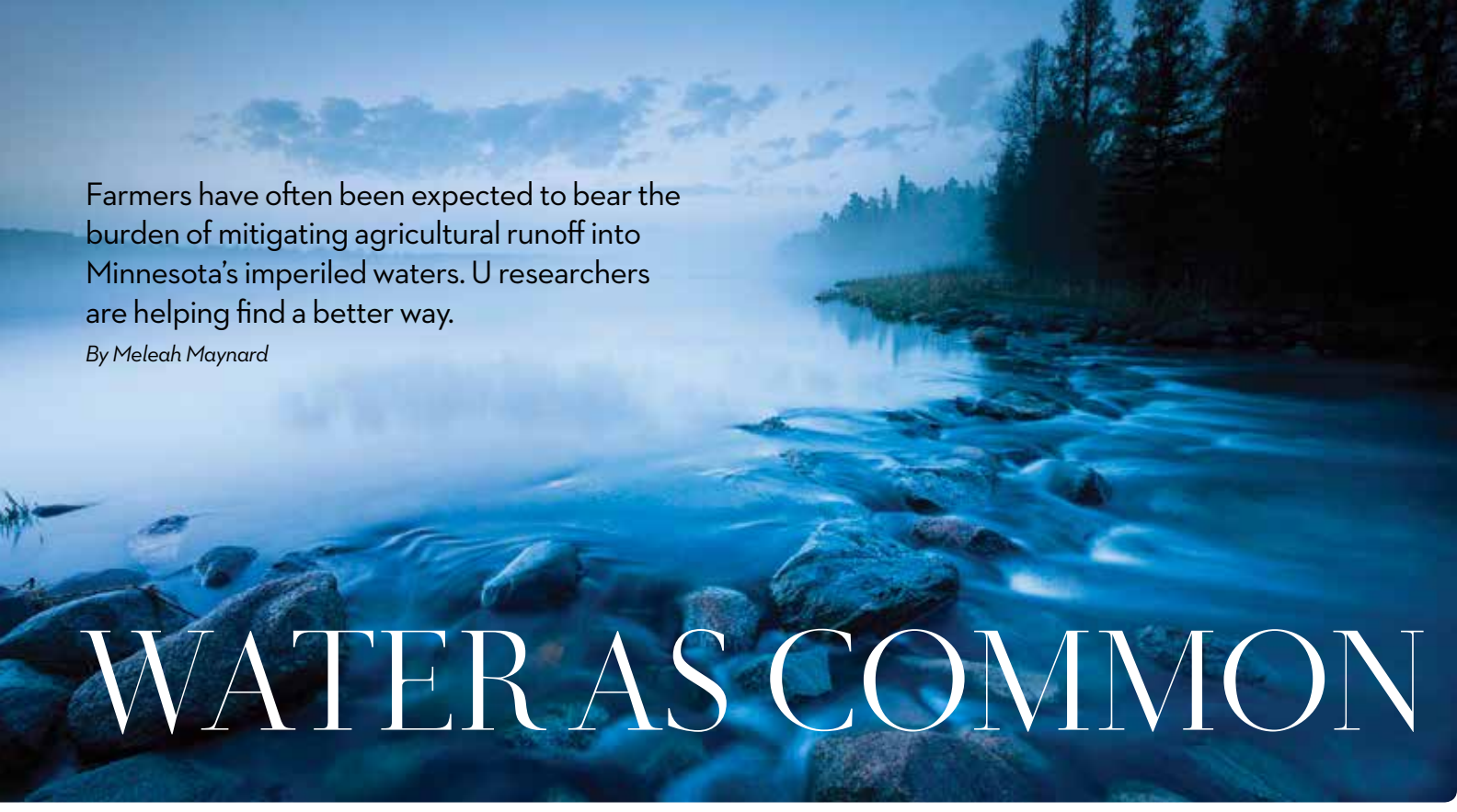

Farmers have often been expected to bear the burden of mitigating agricultural runoff into Minnesota's imperiled waters. U researchers are helping find a better way.

*By Meleah Maynard*

# WATER AS COMMON

AT A TIME WHEN much of the world is facing drought, water shortages, and other serious water-related problems, it's easy to see Minnesota—the Land of 10,000 Lakes—as being safe from such worries. But that is not the case. In fact, the state's water supplies are facing many challenges, issues so serious that last August Governor Mark Dayton announced a "Year of Water Action" in Minnesota, urging everyone in the state to take action to conserve and improve water quality.

Dayton's action followed several reports by the Minnesota Pollution Control Agency (MPCA), including one in February noting, among other things, that nearly two-thirds of test wells in central Minnesota have levels of nitrate that exceeds the state's drinking water standards. That's significant because nitrates can cause a potentially fatal blood disorder in infants called blue baby syndrome. A subsequent report concluded that more than 40 percent of Minnesota's waters were considered to be impaired or polluted—additional lakes, rivers, and streams are added each time there is new study is completed.

While several factors contribute to the state's water problems, the MPCA has continually pointed to one threat in particular: agricultural runoff. Soil, nitrate and phosphorous fertilizers, and other contaminants often flow off of farm fields and into nearby waterways. And because this type of cropland runoff is exempt from state and federal pollution regulations, it's up to farmers to voluntarily change their practices to help improve water quality. Some Minnesota farmers are already adopting clean water practices, such as planting cover crops, using less fertilizer, and using grass buffers to absorb fertilizer runoff. But others are skeptical of the MPCA's findings. Many argue that ideas aimed at mitigating runoff often place an unfair financial burden on farmers and more ought to be done to offset associated costs and potential yield losses.

The complexity of the issue is longstanding and undeniable, says Jeff Peterson, director of the University of Minnesota's Water Resources Center. Peterson, who has been working on issues related to water and agriculture for nearly 20 years, says the state's water quality problems are getting worse, in some ways, due to climate change that is producing earlier and heavier spring rains. "We are getting more rain than we used to in the spring when crops haven't been planted yet, which means more water is coming off the land and bringing sediment, nitrate, and phosphorous with it into streams and rivers," he explains. Also contributing to increased runoff, he says, are changes in land use. In recent years, the trend has been to plant fewer perennial crops like alfalfa, which help hold the soil in the spring, and more corn and soybeans, which means soil is bare more of the year.

With these things in mind, University researchers are exploring many ideas, innovations, and technologies aimed at reducing agricultural runoff's affect on water quality. Some are already making a difference for farmers and the environment in large and small ways. Work by David Mulla, cofounder of the U's Precision Agriculture Center (read more about his work on page 20), for example, is enabling farmers to use technology to conserve water and reduce the use of fertilizers and herbicides.

Scott Wells, an assistant professor in the department of agronomy and plant genetics, is one of several researchers

Brian Peterson/StarTribune

# GROUND

working with the Forever Green Initiative. A program of the University of Minnesota and the USDA Agriculture Research Service, Forever Green aims to develop crops that improve soil and water quality while also offering new economic opportunities to farmers.

Wells is part of a team working to develop cover crops that will boost soil health while also reducing erosion and soil runoff to keep the water cleaner. Widely used elsewhere in the country, cover crops are traditionally planted after the last harvest of crops like corn and soybeans and then killed before spring planting begins. Here in the upper Midwest, though, the short growing season makes cover crops more challenging. "We've surveyed farmers in the upper Midwest and they tell us it's too cold, too wet, and they don't have enough time to plant before the frost," says Wells.

The answer may lie in the development of winter hardy annual oilseed crops, such as winter camelina (false flax) and pennycress (a part of the mustard family), which can be planted in autumn following crops, including small grains, silage corn, and sugar beets. Because they can survive into spring, these crops generate revenue while also helping to reduce soil erosion and runoff. Later in the summer, farmers are still able to plant soybeans and other late-season crops as they normally would. Details of this type of dual-cropping system are still being worked out, but Wells and others have demonstrated the concept's viability and promise.

In addition to new winter annual crops, the researchers are also investigating the possibility of planting corn and

From its headwaters at Itasca State Park in northern Minnesota (above left) to the Delta in Louisiana, the Mississippi River accumulates agricultural runoff and other toxins, creating a hypoxic (low-oxygen) zone, commonly called dead zone, near where it flows into the Gulf of Mexico. Size estimates of the dead zone vary from 5,000 to 8,000 square miles.

NASA/Landsat/Phil Degginger/Alamy Photo

"We're looking at ways to intercept that nitrogen in the field or at the edge of the field before it gets very far downstream. That's what keeps us working fervently in this area." —GARY SANDS

soybeans along with perennial cover crops, such as fine fescues and kura clover. "Previous research has shown corn and soybean yield reduction when they are integrated with a continuous living cover crop, but we are closing that yield gap," Wells explains. "This strategy has the potential to reduce offsite movement of nutrients, so it could be an important part of the tool kit to protect wells."

Gary Sands, an Extension engineer and a professor in the Department of Bioproducts and Biosystems Engineering, is tackling water quality by focusing on agricultural drainage. Like irrigation, agriculture depends on good drainage, which is especially important in the upper Midwest where the clay soil may be fertile, but its tendency to hold water can be detrimental to crops.

In Minnesota, thousands of farmers rely on artificial drainage to channel excess water off of their land. Some make use of above-ground ditches while many use drain tiles, so named because the underground drainage systems, which are now made of plastic tubing, used to be made of clay tile. This may be good for farms and agricultural production, but drainage water may carry soil, fertilizers, and other chemicals downstream to the Gulf of Mexico, creating a massive dead zone: an oxygen-starved area the size of Connecticut where very little can survive.

Because coastal oxygen starvation is primarily driven by nitrogen, finding ways to reduce the soil nutrient's presence in runoff is a key part of Sands' research. "We're looking at ways to intercept that nitrogen in the field or at the edge of the field before it gets very far downstream," he explains. "That's what keeps us working fervently in this area." Along with other researchers, Sands is exploring the use of saturated buffers along the edge of farmland. Usually about 10 to 50 feet wide, the grass buffers would act like a filter by absorbing nitrogen from water flowing from outlet pipes engineered to veer off from drain tiles in certain spots. "We didn't come up with this idea, but we think it has tremendous potential for ecological benefits," he says.

Additional strategies are described in *Ten Ways to Reduce Nitrogen Loads from Drained Cropland in the Midwest*, a 2016 publication by the University of Illinois Extension to which Sands and other researchers contributed. "We recognize the complexity of why our agricultural systems look the way they do today, and we are working to reduce the environmental footprint of that system," he says. "One of the biggest challenges we have to address is that improving water quality is for the common good, but there is an imbalance if society reaps the benefits of addressing this problem while the costs fall primarily on the backs of farmers."

# TURNING OVER THE FIELDS

## Pat Duncanson still lives in the house he grew up in and farms the same land his parents did. Now he's preparing the next generation to take over the family farm.

*By Chris Smith ✹ Photo by Mark Luinenburg*

DRIVING THROUGH SOUTHERN Minnesota toward the farm of Pat Duncanson (B.S. '83), it's easy to get lost in the urban stereotypes of farm life: simple and solitary, attuned to the seasons, often hard and dirty, but ultimately beautiful. As I learned more than two decades ago, though, when I visited the farm several times for a lengthy article in this magazine tracing a year in the lives of three Duncanson families, the reality of farming is more nuanced and complicated. Farming is a life ruled by complex economics and changing technologies, by small decisions amplified over thousands of acres. As Duncanson enumerates at his kitchen table, the elements necessary to build a thriving farm sound like those for any business: continuing education, networking and information exchanges, marketing and financial savvy, and boldly grasping new technologies. "Those are all the things I learned to do at the U," he says.

Then, as now, farmers like Duncanson hedge against variables like weather and fluctuating markets by pursuing complex strategies in land ownership and leasing, crop and livestock mixes, precision farming, and market timing. "My role has been evolving," Duncanson says. "I spend time every day looking at the markets, reading, listening, in web meetings. . . . Lots of places have good weather and good land. It's oftentimes the management and the people and connections that makes the difference" in having a successful farm.

In early April, the principals of the farm—Duncanson, his wife, Kris, and his nephews Karson and Kameron (B.S. '06)—sat down with a facilitator for strategic planning, charting