

Wheat: 'We have made a step forward'

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Dubcovsky leads the research for WheatCAP, a consortium of 41 breeders and researchers at 22 institutions in 20 states.

Researchers have identified most of the genes that contribute to a good bread, including protein, loaf volume and uniformity, and use molecular markers to select for those traits.

Has he finally cracked the trait?

"I think we have cracked the easier part of this difficult problem," he said with a chuckle.

How it works

In the future, farmers holding a new variety of wheat in their hands won't see any difference from today's wheat, Dubcovsky said.

But "if you look at the end of the spike, you have one more spikelet at the end," he said.

The plant's genes determine when to stop producing those spikelets, which hold the grain, he explained. Researchers want to enable the plant to produce spikelets a little bit longer.

The newly discovered gene, designated WAO1, controls the maximum number of grains in a wheat spike. Breeding it into plants could make room for more grains to grow in each spike by delaying formation of the terminal spikelet.

"The only thing you will notice is that a spike will be a little bit longer and have more of those spikelets on the side," he said.

Step by step

At its core, yield is measured by the number of wheat spikes per square foot of land, multiplied by the number of grains each spike has, multiplied by the weight of each grain, Dubcovsky said.

"One of those components, the number of grains, is a little bit easier to do genetics with," he said.

Researchers have identified several genes that control the weight of grains, he said.

But a plant with more grains has to produce enough starch to fill them, or else farmers will end up with more but smaller grains, and a plant producing the same yield.



Joel Mackendorff/UC-Davis

University of California-Davis wheat breeder Jorge Dubcovsky recently identified the WAO1 gene, which controls the maximum number of grains in a wheat spike and could help researchers and farmers boost yields by 5%.

Now, researchers are working on the more difficult part of the question, Dubcovsky said: making a more robust plant, with more biomass, that can mobilize more starch to the extra grains to increase yield.

"We have made a step forward," he said. "We have half of the equation solved."

The gene already existed in half of the modern wheat varieties in the world, he said. Identifying it may benefit those varieties that didn't already have it. WAO1 is frequently found in wheat varieties used to make bread flour but not in pasta wheats such as durum.

"We know now in which varieties it's present and which it's not present," he said. "We didn't know that before. We were blind."

But it will be years before higher-yielding wheat varieties appear in farmers' fields. New varieties take 5 to 10 years to develop, Dubcovsky said.

"The reality in breeding is that we go step by step," he said. "In plants that have a good biomass, you can push yield 5%."

That might not sound like much of an improvement at first.

But given that the world's wheat farmers raise 750 million metric tons each year, and wheat produces 20% of calories and protein consumed by the human population, and the need to soon feed 3 billion more people on the same amount of land, "that 5% starts taking a different perspective," he said.

Two farmers

Gary Bailey and Andy Juris raise wheat about 200 miles apart in Washington state. For both farmers, yield is a major consideration when deciding which varieties to plant.

Their farms receive different amounts of rain.

Bailey farms in St. John and represents Whitman County farmers on the Washington Grain Commission board. His land can receive 14 to 17 inches of rain per year — a lot for this part of the state.

For him, a typical winter wheat yield is about 80 bushels per acre.

Juris farms in Bickleton and is vice president of the



Gary Bailey



Andy Juris



Mary Palmer Sullivan

Washington Association of Wheat Growers. His farm normally receives 8 to 10 inches of rain each year — although last year during the drought it got 3 inches.

In a fallow rotation, in which he rests his soil some years, his average yield is 35 to 40 bushels per acre.

Where he does annual cropping in shallow soils that can't hold precipitation, he averages 25 bushels per acre.

Dubcovsky's 5% increase would mean a bushel or two more per acre, Juris said.

"We're kind of clinging on sometimes by our fingernails to the margins of what is considered decent, farmable ground," he said. "We're always looking for that next percentage."

"The low-hanging fruit has all for the most part happened already," he said of other ways to boost yields such as fertilization.

Since Bailey began farming 33 years ago, wheat yields have increased 15% through various factors, he said, adding that 5% more would be welcome.

Time will tell

Breeders in the Pacific Northwest say Dubcovsky's discovery will put another tool in their toolbox.

Identifying the gene won't directly affect general breeding efforts in the near future, but could help breeding for specific production systems long term, Washington State University spring wheat breeder Mike Pumphrey said.

If the gene's already present in Oregon State University's germplasm, molecular markers can be used for marker-assisted selection, said OSU breeder Bob Zemetra.

If not, it could be bred into elite germplasm and evaluated to determine the impact on yield, he said.

Everyone agrees on one point: Quality must not be sacrificed.

Yield pays the bills, but if a grower is discounted for

low quality, that can change how much they're paid in a hurry, said Mary Palmer Sullivan, vice president

of the Washington Grain Commission.

Pumphrey recommends growers watch reliable, replicated, multi-year, multi-location regional yield performance data, while considering other traits of importance.

As part of the Wheat-CAP consortium's \$15 million grant from the USDA National Institute of Food and Agriculture, researchers are evaluating the effect of the genes in combination with other traits for increased yield, said Arron Carter, winter wheat breeder at WSU.

Researchers need to take a holistic approach with all components of production, Carter said, adding that top yield is dictated by genetics, climate, inputs, cropping system and soil health.

"I don't think we have reached our limits yet," he said. "I think genetics can continue to push yield higher."

GMO quandary

Years ago, corn and soybean yields skyrocketed with the advent of genetically modified organisms, or GMOs, in which genetic traits such as pest resistance are inserted into the varieties.

The global wheat market, however, has not embraced the technology. As yet, there are no commercialized varieties of wheat available in the market developed through biotechnology.

"It is unfortunate that we cannot use GMOs in wheat, because we can do a lot more," Dubcovsky said. "Basically, you are asking us to give you more food in the same space, and you tied our hands at our backs. But since those are the rules, we continue to do breeding with our hands tied at our backs."

Breeding will continue to improve without GMOs, he said. But GMOs would allow solutions to a lot of problems, including nutrition and the economic value of wheat.

"I understand, people always fear what they don't know, and we need to respect people's fear," he said. "From a scientific point of view, there's no rationale on the limitations they are putting upon me (with) GMO. But I respect the people — if people do not want to eat them, I will not produce it."

Investing in food

Dubcovsky, 65, said it's also time to find a younger researcher to overlap with him at UC-Davis to eventually take up the mantle.

"In the meantime, I will continue doing it, I enjoy doing it," he said.

Even when a new person arrives, he'd happily keep helping out.

"This is my passion, so I will proudly continue working on it," he said.

Sullivan, of the grain commission, notes that Dubcovsky identified the gene through federal research funding.

"While each state that has a checkoff for wheat contributes towards research, we can't do it alone," she said. "These are the types of grants and opportunities that we wouldn't otherwise have. The more information, and the more tools they have in their toolbox, the better off we're going to be. It's a really good investment in taxpayer dollars."

Dubcovsky echoed the need to support agricultural research.

"Food is not something that's sold in the supermarket," he said. "Food is something you need to fight for and you need to invest for, if you want to have food on the table tomorrow. Producing food takes work of a lot of people."

Dubcovsky left research on yield for the end of his career because he knew it would be difficult.

Making a more productive plant requires a plant that grows faster, a little taller, with a stronger stem to support more grain.

It can be done, he said, pointing to triticale, a cross between durum wheat and rye, which has some of those traits.

"We know that it's possible," he said. "Now we just need to figure out how to get there."



NRCS

Scott Pattee, NRCS Washington Snow Survey water supply specialist.

Snowpack: 'I think La Nina's effects are really going to taper off'

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Washington State Climatologist Nick Bond attributed the April snowpack turnaround partly to chance and partly to a late-arriving La Nina.

"I think right now we're still feeling to an extent the lingering effects of this La Nina," he said. "I think La Nina's effects are really going to taper off."

La Nina conditions, triggered by cool Pacific Ocean temperatures, are linked to chilly winters in the northern tier of the U.S. and milder weather in the southern tier.

Oregon, Idaho and Montana snowpacks improved in April. Snowpacks in the Southwest such as in Arizona and New Mexico declined.

"It's usually that way in

the West. If somebody gets water, somebody doesn't," Bond said.

Washington Gov. Jay Inslee issued a drought emergency for the most of the state last July. The declaration expires June 1, and state officials will meet this week to discuss extending or revising the declaration.

The declaration excluded central Puget Sound, including Seattle and Tacoma. Marti said the declaration probably will be lifted in Western Washington. April improved the summer outlook east of the mountains, particularly in the Walla Walla area, he said, though the region has a long-term rain deficit.

The federal U.S. Drought Monitor classifies the eastern half of the state in drought, including 7% in "extreme drought."

Water: District has proposed charging ag water users a higher rate this year

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by region, the universal theme is that drought hurts suppliers and farmers.

One example of a district facing escalating costs is Valley Water in San Jose, Calif.

The district's staff has proposed charging agricultural water users a higher rate per acre-foot this year: up to 8% more for groundwater and 11.9% more for surface water.

Matt Keller, district spokesman, said there are a few reasons behind the proposed increase. First, the district may buy "emergency water" on the open market. Second, it must continue to maintain and repair conveyance systems, expand recycled water delivery and build infrastructure.

Nearby Westlands Water District faces similar expenses. Deputy general manager of resources Russ Freeman said Westlands also gets costs passed on to it from the U.S. Bureau of Reclamation, which operates the Central Valley Project.

Reclamation's primary revenue comes from contractors, including irrigation districts, paying for deliveries. If drought forces the agency to deliver less water, that means less revenue.

"We still need to do our basic program," said Ann Lubas-Williams, financial manager at Reclamation.

According to Sabir Ahmad, rate-setting manager at Reclamation, the agency develops annual water rates based on projected costs and deliveries.

For the Central Valley Project, Ahmad said, Reclamation is required to publish a proposed draft rate Oct. 1 and final rate Dec. 31.

The challenge is predicting spring precipitation.

Dec. 31, 2021, after heavy snowfall, Reclamation estimated the operations and maintenance cost for the Central Valley Project at \$31 per acre-foot. Then came one of the driest January-through-March periods on record. Now, the cost is \$132 per acre-foot.

Because Reclamation is undercharging irrigation districts this year, it will collect on the \$101 per acre-foot difference, or "deficit," next year. Contractors will have two choices: pay the deficit in 30 days with no interest or pay by 2030 with interest.

Either way, Reclamation is passing on its costs. Some districts will then pass on their costs to farmers.

In Eastern Oregon, Owyhee Irrigation District is raising its assessment \$1 per acre in 2022 to account for drought costs and inflation. Clancy Flynn, manager, said drought means more man-hours: keeping canals trimmed, headgates set, cleaning weeds off screens and filing paperwork.

Josh Bailey, who manages North Unit Irrigation District in Central Oregon, said weed management is more expensive during drought. As farmers fallow fields, weeds spread to canals and laterals. Bailey said the district has seen a "massive increase" in costs to control weeds and pay overtime.

North Unit is dipping into reserves rather than increasing rates this year, but reserves won't last forever.

In Southern Oregon, Klamath Irrigation District also faces catapulting costs.

Gene Souza, district manager, said

canals that haven't seen water in 18 months are strewn with weeds and pockmarked with burrows made by badgers, muskrats and yellow-bellied marmots.

In the northern part of the district, where soils are clay-based, parched canals are cracking, requiring the district to send out ditch riders to fill cracks with bentonite clay. In the southern region, where soils are sandier, canals are crumbling, so the district has to install geomembrane liner at \$8 to \$15 per foot.

"Regardless of whether I deliver (farmers) a drop of water or not, I've got to maintain the system," said Souza.

Farmers won't pay for water they don't receive, but they will pay assessments to maintain delivery systems.

Klamath Irrigation District isn't raising rates this year, instead running on reserve funds and incoming state and federal dollars. But if drought continues, Souza said, reserves could run dry.

"If we don't increase rates next year, will we be here in 2024?" he said.

Although Idaho and parts of Washington also face tight supplies, district managers said their states are better-positioned.

"We're not as bad as Oregon," said David Christiansen, manager of Idaho's Snake River Valley Irrigation District.

Christiansen said his district is experiencing inflation but hasn't yet seen drought-related costs.

"I'm preparing for the worst, hoping for the best," said Christiansen.

But for some farmers, like California walnut grower Tim McCord, the worst has already come.