New tech targets high-yield alfalfa

Hay & Forage Grower is featuring results of research projects funded through the Alfalfa Checkoff, officially named the U.S. Alfalfa Farmer Research Initiative, administered by National Alfalfa & Forage Alliance (NAFA). The checkoff program facilitates farmer-funded research.

THE use of genomic and phenomic technologies in alfalfa breeding programs could help enhance alfalfa yield, said Charlie Brummer, Center of Plant Breeding Director at the University of California (UC)-Davis.

Genetic markers, genomic predictions, drone-based sensors, and different statistical tools were used in his work to maximize alfalfa yield, funded by the Alfalfa Checkoff. Genetic markers were used to screen plants "so we could see which ones were the best at making great progeny (half-sib families), then cross them for a better estimate or idea of what's going to be a good, high-yielding cultivar," Brummer said.

CHARLIE BRUMMER
Funding: $49,796

He experimented with 200 half-sib families from UC-Davis breeding populations in 2017, 2018, 2019, and 2020, each year evaluating them for vigor and yield. By 2021, individual plants and half-sib families were identified with high biomass yield to produce experimental cultivars.

"We've made progress. We know all the steps of the process, and we've applied them all to our current breeding," Brummer said. "Now it's a matter of producing seed to document the changes that we think happened, and seeing the gain that we think we've made in terms of yield."

This summer, plants are being intercrossed, then evaluated in the next year under full and deficit irrigation and saline and nonsaline irrigation. "It will still take a couple of years after we get the seed of populations until we get trial results," Brummer pointed out. "Everything looks favorable that we are able to improve yield, and that these technologies can be applied to commercial breeding programs. But it's going to be incremental yield gains; it's not going to be an immediate 10% jump," he added.

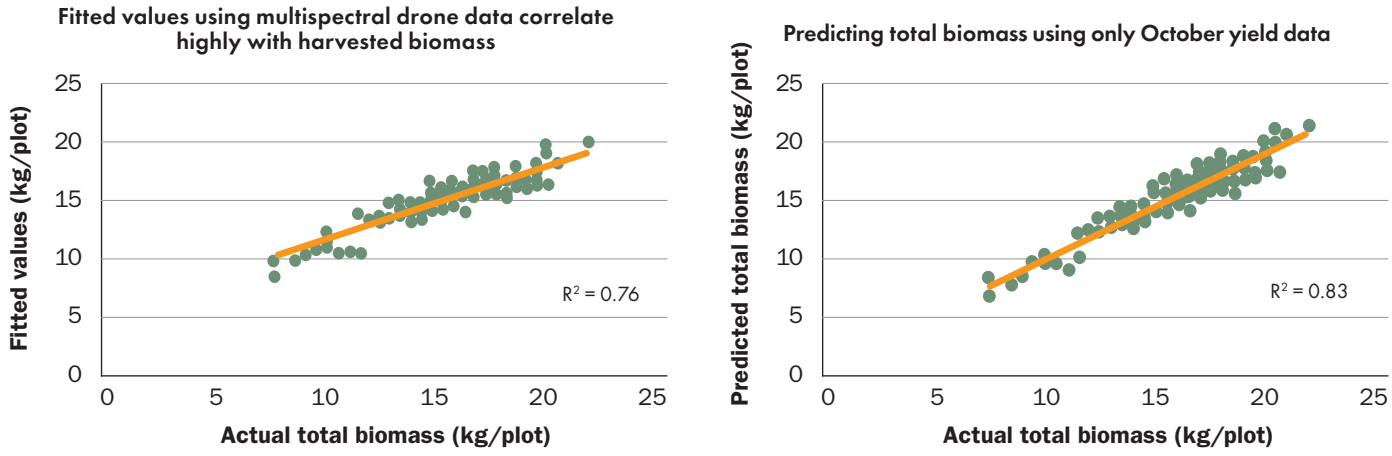
Saving time and money

Brummer hopes the research will also help speed up the alfalfa breeding process. He explained, "We used a whole suite of technologies, including genetic markers for whole genome analysis to predict yield and drones to estimate yields remotely rather than having to harvest plots, plus better statistical techniques to analyze data more robustly."

PROJECT RESULTS

1. Individual plants and half-sib families with high biomass yield were identified to form new experimental cultivars. Populations selected for vigor from spaced plant trials will be compared with those selected for yield from sward trials. DNA marker data for two populations will be used for marker-only selection in early 2022.

2. Collecting data using multispectral and hyperspectral cameras (on drones) in 2019, 2020, and 2021 was useful for predicting yield in certain harvests. In other harvests, especially in the spring of the first year when all plots looked good or when yield variation among families was small, the relationship between drone data and actual yield was moderate. Predicting yields in some harvests, for example by measuring one replication with a harvester and predicting other replications without taking yield measurements, could expand the number of families or populations evaluated at a given time. Because breeding is a numbers game, evaluating more families should result in better genetic gain for yield.



Figures: Brummer's research shows drone-based predicted yields (right) can closely compare to actual measured yields (left), suggesting the value of using drones to speed data collection of some harvests.

Drones worked well in collecting data. "The time savings and money savings in flying drones rather than harvesting hundreds and hundreds of plots is fantastic," Brummer said. The challenge is figuring out how to process the data in a streamlined way.

"We need to better understand how the plant grows and how we could potentially modify it and think about modifications that could lead to higher yield," Brummer said. "With drones or other types of sensors where you could possibly get real-time data all day long, what does that tell us? Could we use all those data to potentially change our evaluations and our selections from what we do now? That's a challenge," he asserted.

Another challenge is the crop itself, Brummer noted. "Working on a perennial crop takes time; it's hard to do experiments on a yearly basis or even over a couple of years. It takes time to do experiments in breeding, develop new populations, then test them, so things don't move as fast as any of us would like," he said.

Brummer also pointed out that this research wouldn't exist without grower checkoff funding, "It's hugely important to those of us in the public sector to have that source of funding." ●

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