Researchers screened nearly 3,000 chemicals produced by plants, then narrowed the list to 20 that could promote bacterial biofilm formation.

Gene-Edited Wheat For Sustainable Farming

Scientists at the University of California, Davis, led by Distinguished Professor Eduardo Blumwald, have pioneered a breakthrough technology that could create wheat crops that fertilize themselves, dramatically reducing farmers' reliance on chemical fertilizers and reducing global pollution.

By harnessing the CRISPR gene-editing tool, Blumwald's team has enabled wheat plants to produce more of a naturally occurring chemical, which then stimulates soil bacteria to convert atmospheric nitrogen (N) into a form usable for plant growth. This process, known as nitrogen fixation, is common in legumes but has so far eluded cereals like wheat.

Legumes such as beans and peas have root nodules that house nitrogen-fixing bacteria in low-oxygen environments. This symbiotic relationship is why legumes require less nitrogen fertilizer.

"For 50 years, scientists have tried to bring N-fixing bacteria (engineered or modified) inside the plant, somehow trying to emulate the strategy that legumes use," Blumwald explains. "This strategy (nodules, symbiosis) doesn't work in cereals because of many reasons. Mainly, cereals can't make nodules in their roots. These nodules are critical, because they're full of leg-hemoglobin that can bind oxygen, thus generating conditions where the very low oxygen concentrations can't harm the bacterial nitrogenase, as the bacteria live inside the nodules."

Blumwald's insight was to alter the approach. Instead of forcing bacteria into cereal roots, he focused on encouraging bacteria in the surrounding soil to fix nitrogen, and the ammonium (which contains the fixed nitrogen from the air) could diffuse through the soil into the roots. The team screened nearly 3,000 plant-produced chemicals, narrowing the field to 20 that could promote bacterial biofilm formation. Biofilms, covered in a substance impermeable to oxygen, protect the critical nitrogenase enzyme.

"It wasn't easy," Blumwald proclaims. "I found two, and I centered on apigenin."

Using CRISPR, the team engineered wheat to produce excess apigenin, a flavone released through roots that stimulates bacteria to build protective biofilms. Experimental results are promising. Wheat plants grown with limited nitrogen fertilizer but engineered to produce apigenin showed higher yields than their unmodified counterparts.

The potential impact is enormous, especially in developing countries where the cost of fertilizer restricts crop yields.

"In Africa, people don't use fertilizers because they don't have money, and farms are small, not larger than six to eight acres," Blumwald says. "Imagine planting crops that stimulate bacteria in the soil to create the fertilizer the crops need, naturally. Wow, that's a big difference!"

Wheat is the world's second most important cereal crop and accounts for about 18% of all nitrogen fertilizer use. In 2020, more than 800 million tons of fertilizer were produced worldwide. American farmers alone spent $36 billion on fertilizers last year, planting nearly 500 million acres of cereals. This innovation promises not only cost savings for farmers but also environmental benefits, such as reduced water pollution, less ozone layer depletion, and improved food security.

"This breakthrough will contribute to the reduction of inorganic N fertilizers," Blumwald claims. "There will be plenty of money savings, a reduction of eutrophication of our waters, and a reduction in the depletion of the ozone layer by nitrous oxide (produced by denitrification of the inorganic N fertilizer in the soil). If we could save 10% (I'm calculating conservatively) of the amount of fertilizer used on that land, it should be a savings of more than a billion dollars every year."

Building on earlier work with rice, Blumwald's team is now extending this technology to other cereals, including maize and sorghum. If successful, gene-edited crops could soon usher in a new era of sustainable agriculture — where plants help feed themselves, farmers save money, and the environment benefits.

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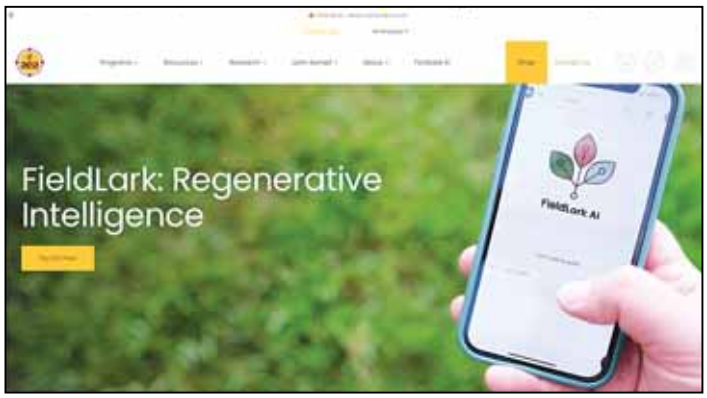

FieldLark can interpret sap or soil tests and other test results or documents, as well as identify diseases from photographs.

Regenerative Ag Chatbot Advisor

Farmers interested in regenerative farming can find answers online from FieldLark. Advancing Eco Agriculture's AI-powered agronomist chatbot provides recommendations mainly based on founder John Kempf's speeches, books, articles and field research. Kempf has gained a national, if not international, following for his regenerative agriculture efforts and a line of products.

"We've trained FieldLark on journal articles and books we rely on and value, as well as conversations John has had with farmers, consultants and researchers," says John Ela of Advancing Eco Agriculture. "The database includes about 10 years of plant analysis on more than 100 different crops, as well as another 10 years of organizational experience. As important as the data is the framework we have given it. It has top-level instructions to follow a value system aligned with ecological principles and other frameworks for how it thinks."

Users can simply ask questions. They can also upload photos of pests, damaged crops and more to get responses and recommendations from FieldLark. Initially, FieldLark only used Kempf-related data when providing a response or recommendation. Ela says it now draws on additional online sources.

"We've added instructions or guardrails to ensure it doesn't utilize marketing material from commercial companies," says Ela.

Outside data is channeled through the overlying framework.

"FieldLark comes to a lot of conclusions on its own, such as stating that anhydrous ammonia is quite bad," notes Ela. "We didn't train it to say that; however, because the framework prioritizes health and ecological effects, it came to that conclusion."

Ela admits that, like any AI system, FieldLark could potentially hallucinate, making up an answer if no relevant data is available.

"We haven't seen that yet, but there's always a risk of receiving bad information," says Ela. "We always recommend if the topic is mission-critical or requires an investment, it's always good to get a second opinion."

If no other resources are available, Ela suggests reframing the question and comparing responses. It's also possible to ask FieldLark for the origin of the information and to review the citations provided. As with any new practice, regardless of the source, he advises conducting a trial on a limited number of acres based on the level of risk.

"You can even have an interesting conversation with FieldLark about itself," says Ela. "We have an 80-page document based on John Kempf discussing its growing awareness with it."

Ela suggests that talking to FieldLark can assist in getting help from it.

"You can ask it what questions to ask and how you should approach a subject," he says. "Ask how it can best help solve the problem. Provide location soil tests and other available data. Include objectives as well as past challenges. The more context or data you can provide FieldLark, the better the answer it can give."

FieldLark has received glowing testimonials from users and non-ag recognition. Recently, thanks to FieldLark, the company was named one of the most innovative companies in agriculture by Fast Company. The business magazine emphasizes innovation in technology, business and design.

Visitors can try FieldLark for free with a limited number of questions. FieldLark Standard costs $29.99 per month and includes 75 questions with no daily limits, plus email support. FieldLark Pro is $149.99 per month and provides unlimited questions and priority support.

All users receive app-like mobile access on their devices. Past chats can be reviewed and expanded. FieldLark can interpret sap or soil tests and other test results or documents, as well as identify diseases from photographs.

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