

A scenic farm landscape at sunset. The foreground is a golden field of harvested crops, with several large, rectangular hay bales in the middle ground. In the background, there are farm buildings, including a large white barn and a smaller yellow house, surrounded by trees. The sky is filled with soft, colorful clouds in shades of orange, yellow, and blue.

# Today's **FARM**

FALL 2023

A supplement of the **Journal Review**

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# Putting Safety First

Agriculture is one of the most hazardous U.S. industries.



Hundreds of farmers and ranch workers die annually from work-related injuries. Their work takes place outdoors in difficult conditions and often happens around hulking, dangerous machinery. Still, we should all strive for a safer operation where the rewards outweigh the risks. Here's how.

## TRACTOR AWARENESS

There are many risks associated with this industry, but the National Institute for Occupational Safety and Health points to one critical area of concern: Tractor overturns have remained the leading cause of farm injuries. Owners and operators should take this continued risk to heart when purchasing equipment, training staff and discussing work habits. Avoid loose-fitting clothing while operating farm equipment, since baggy pants legs, sleeves and shirt tails might get caught in machinery. Always turn off the tractor before removing the seat.

power take-off shaft was developed in the 1930s as a means of transferring tractor power to various implements. The National Farmers Union reminds workers to avoid reaching over a PTO while it's in operation. Many come equipped with shields, but entanglement is still possible. Disengage the PTO before leaving the tractor.

## ATV ISSUES

Small all-terrain vehicles have become the go-to vehicle for many farmers because of their

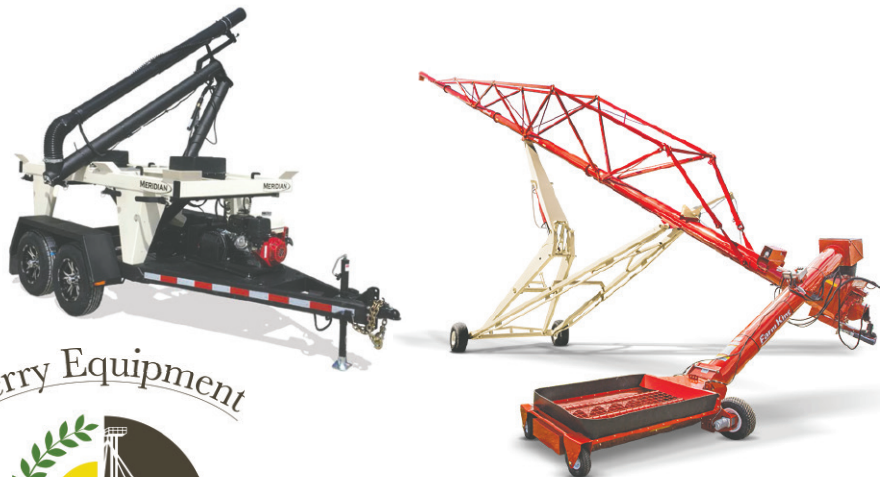
agility, maneuverability and cost-effectiveness. They're particularly useful when monitoring livestock, checking fence lines or inspecting irrigation systems, among other regular farm tasks. Rough terrain presents a danger, however, so ride alone when possible, and pay close attention to speed. Too much weight can make steering more difficult, even in the best conditions.

## CRITICAL MEASURES

Protect drivers by installing roll-over protection kits on older

tractors, or upgrade to safer new models. The kits can be expensive, but they're a critically important safety measure that could save a life should an accident occur. Purchase and install reflectors, lights and flags if you're going to be operating an ATV around larger vehicles, to increase visibility. Every farm is unique. So, talk to local agricultural extension offices, your insurance agent or supply store representatives about additional safety tips that are specific to your climate and terrain.

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# Saving Water

Conservation opportunities abound for farm operations of any size.

Farms and ranches need a lot of water to operate. In fact, the U.S. Geological Survey reports that about 70% of all freshwater withdrawals are for agricultural purposes. That makes conservation a critically important focus, even when your area isn't experiencing drought or other shortages.

## NEW TECHNOLOGY

As with so many things in our modern world, new technology has had a huge impact on water conservation efforts. A growing awareness of usage and the underlying reasons for periods of scarcity has also led farmers to a renewed emphasis on saving water. New methodologies, tools and equipment are leading the way, as timely innovations make it easier to approach everyday farming operations with an integrated conservation plan. In this way, it's never been easier to preserve one of our most valuable natural resources.

## BETTER IRRIGATION

Farmers have increasingly turned to smart scheduling pat-



terns which can have dramatic impacts on usage while often improving yields. Software programs gather weather data, including local rainfall, temperatures and humidity, then provide targeted times when irrigation is optimal. For the less tech-savvy, local agricultural extension agents, university farming programs, and equipment centers can also provide helpful tips.

In some cases, they may have specific recommendations on what to plant, as well. Some native trees, including willows, cottonwood, Russian olive and tamarisk, consume excessive amounts of water — thereby

reducing the availability of water to nearby crops. Take them into consideration when developing your irrigation plan, or consider removing them, if appropriate.

## CATCHING RAINWATER

New catchment systems can make a huge difference. Harness the power of rainwater by installing a collection apparatus. Larger systems allow farmers to recycle tens of thousands of gallons of water per season, with no additional cost after the catchment is purchased. Local extension offices and trained sales personnel can tell you more about how these systems

work, and which style and size is best for you.

## LEVELING UP

Laser leveling is another newer technology that can reduce water usage when integrated into your farm work. In some cases, water usage was down by as much as 30 percent — while crops increased another 20%. The secret is a laser-driven program that pinpoints problem areas while illustrating ideal land shapes. It's customizable based on differing terrain, climates and irrigation approaches. Runoff is reduced, while water is distributed more uniformly.

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# Loans and Aid

Help is out there for farmers who need financial assistance.

Unfortunately, farmers and ranchers sometimes need a hand, whether they are just starting out or have experienced common setbacks like an economic downturn or a bad season. If you find your-self in a tough spot, here's who to go to for help.

## LOAN REQUESTS

Farming is defined by its challenges. There are tight margins, weather disruptions, pests, equipment issues and a host of other potentially unforeseen variables. Sometimes, a timely loan can help bridge the gap. The U.S. Department of Agriculture's Farm Service Agency offers loans with reasonable terms so farmers and ranchers can maintain their operations. Some temporary measures are specifically designed to help keep a farm up and running until things turn around, while others are aimed at longer-term goals. Talk to local agricultural center representatives about local options and referrals.

## TYPES OF LOANS

Options vary, depending on



circumstances and need.

Operational micro-loans are meant to address everyday issues that may arise, like large-equipment failures during the harvest season. Other eligible needs may include additional fertilizer or seeds. They are tailored around the specific need and size of the ranch or farm. On the other hand, ownership loans are meant to help those who are just beginning their farming operation.

## KNOW THE TERMS

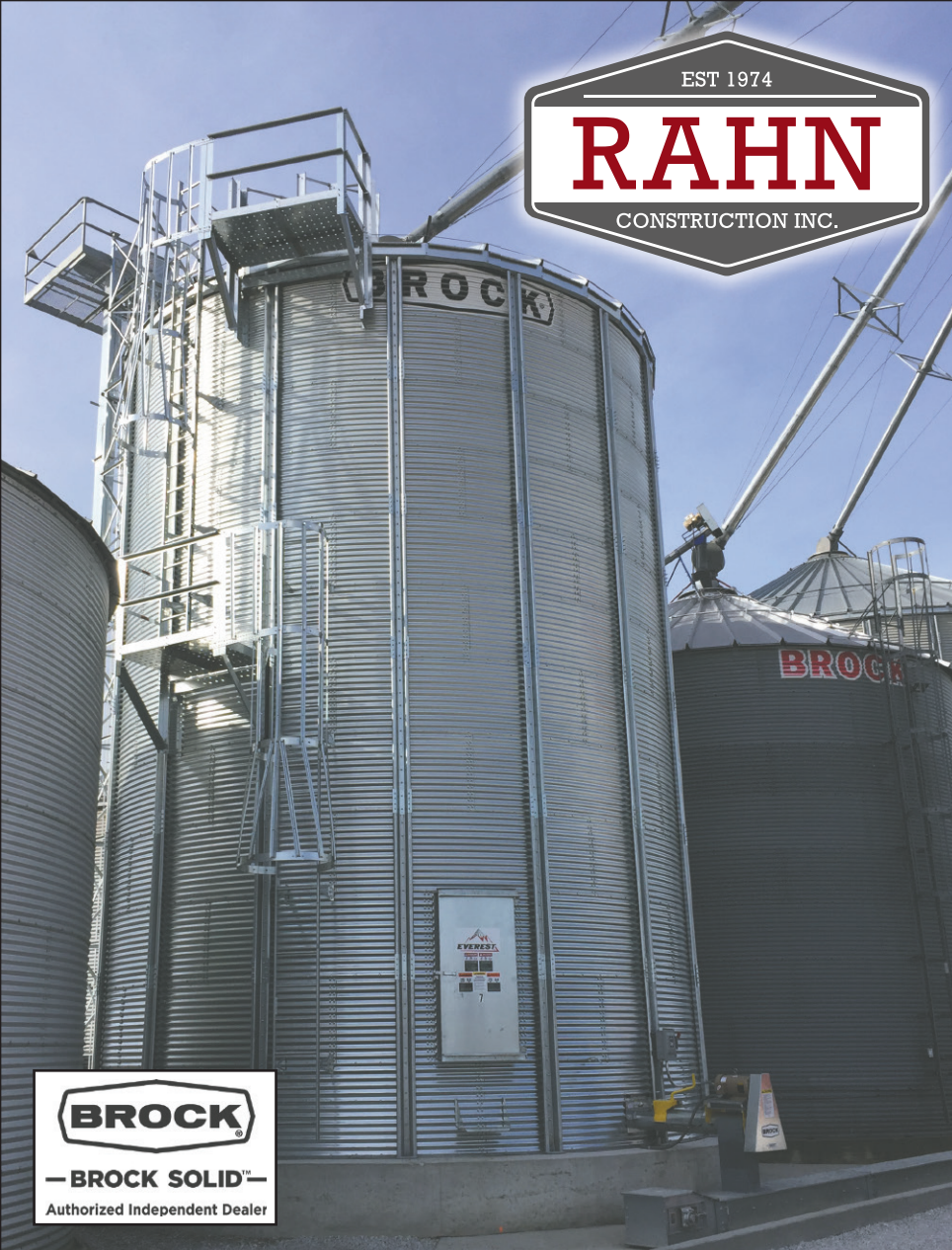
There are qualifying terms for Farm Service Agency loans. Requirements include owning a

family farm, with a strict number of related workers making up management and labor. The primary decision makers for the farm must be a member of the family, though outside workers and even paid consultants are allowed. Applicants must be citizens of the United States, have good credit, and may not be delinquent on any kind of debt to the federal government.

## ADDITIONAL ASSISTANCE

Ongoing aid programs include the Rural Cooperative Development Grant Program, the Value Added Producer Grants, the Beginning Farmer and

Rancher Development Program, the Socially Disadvantaged Groups Grant Program, and the Farmers Market and Local Food Promotion Program, among many others. There are also local and state aid programs. The Specialty Crop Block Grant Program funds projects with innovative ideas for food and agricultural products. New aid programs to help farmers and ranchers also emerged during the pandemic, including the Coronavirus Food Assistance Program, the Pandemic Livestock Indemnity Program, and the Pandemic Market Volatility Assistance Program.



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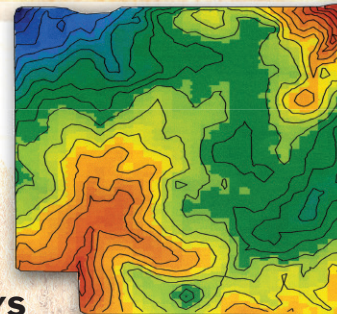
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# Time to Buy New Gear?

Faithful farm machines eventually become run down or simply outdated.

Farms don't succeed without fully operational, safe and dependent equipment. Still, it's an uphill climb against the forces of age, weather and everyday wear and tear. Here's what to consider before you splurge on these often-expensive new machines.

## BEFORE YOU BUY

It's important to ask the right questions before you begin shopping. Consider your financial constraints and long-range plans first: Different equipment is available to suit every size operation. Decide on how much horsepower you need, the necessary technology and accessories, and specifics like wheel spacing, weight and hydraulic capacity. Most of all, develop a strict budget for yourself.

## NEW VS. USED

The first of many decisions you'll have to make before purchasing new farm equipment is whether to take advantage of new or used options. New equipment will be more expensive but also comes with the lat-



est technology, a warranty and related manufacturer support. Used equipment might have its own functionality issues down the road, but you will pay less upfront. Factors like longevity, cost and quality are made on a case-by-case basis, and what works for you might not work for someone else. Before buying any used equipment, carefully inspect the machinery before you buy — or bring in a local professional, if you're unsure what to look for.

## BUY VS. LEASE

In some instances, it might make more sense to lease equipment. These short-term contracts allow farmers and ranchers to use key machinery during the busy season without having to pay for it during traditionally dormant months. This extra income could be used to save for an upgrade on other equipment, or to pay down existing debt. You also don't have to worry about upkeep. The downside of leasing is that tax breaks afforded with purchases aren't in place when leasing.

Buying makes sense if machin-

ery will be in more regular use. There are available tax deductions on the equipment, as well as depreciation considerations. Insurance, repair, fuel and labor costs may also be tax deductible, but only if you purchase. Payments on any financing that's in place can also be reported as deductible expenses. Purchased equipment also becomes a valuable asset when you're ready to trade in for newer models. On the other hand, unlike leased equipment, maintenance, repair and other related costs are your responsibility.

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# The Best Farm Dogs

Hard-working canines are more than family pets on the farm.

Working dogs play a wide variety of roles beyond providing companionship, including herding, guarding and pest control, among others. Different dogs have specific strengths, however, so be sure to match the breed with your specific requirements.

## BEFORE YOU DECIDE

Find a reputable breeder who follows proper protocols and discuss your plans. It's best to adopt canines when they are young so they can become familiarized at an early age with your family, staff, farm terrain, and specific obligations. Most farm dogs are protective by nature, so be prepared to carefully introduce new faces. Once you've determined your needs, it's time to match your farm with a new dog.

## LONG HISTORY

Most people think of canines as family friends, but many domestic breeds were originally developed as working dogs. They played a huge role in farming prior to the 19th century Industrial Revolution, and they are still integral in many



smaller operations. Today, most people think of farm dogs as medium to large breeds, but in earlier, more agrarian eras dogs of all sizes worked on farms.

## SPECIFIC NEEDS

Of the hundreds of registered breeds, the American Kennel Club names only around 30 as members of the herding group. Others — including Airedale Terriers, Anatolian Shepherds and Jack Russell Terriers — are best used for guarding or for pest control. No matter the breed or their natural inclina-

tions, all dogs must have consistent training to meet their fullest potential. Working breeds make good companions, but they are not lap dogs. They are hardy, intelligent and above all athletic. They live for the outdoors, whether herding, playing or guarding.

## KEY CHARACTERISTICS

Ace herders include the border collie, Australian cattle dog, great Pyrenees and German shepherd. The Australian shepherd, another great herding dog, was actually developed in the U.S. — specifi-

cally the high plains of the West. As the name implies, border collies were bred on the border of England and Scotland. Like other herding dogs, Anatolian shepherds make terrific guardians, but are not prone to unnecessary barking — a key personality trait for those seeking a calm presence. Pembroke Welsh corgis were a favorite companion of the late Queen Elizabeth II, but were developed in rural Wales to herd and guard farms. The German shepherd may be the most intelligent and versatile of them all.

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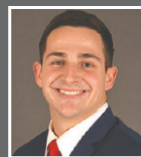
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# Smart Land Purchases

Buying land is a big decision whether you're starting out or looking to expand.

Purchasing land involves a complicated process where farming needs must be balanced with price and debt considerations. Buying at an inopportune time or choosing a poor piece of land can have catastrophic consequences. At the same time, overextending yourself financially could doom your entire operation.

## FUNDING THE PURCHASE

If you don't have enough money to purchase with cash, consider your income-to-debt ratio before extending an offer. There are banking and governmental outreach programs specifically designed to ease the way for farmers to expand their operations or for new farmers to get underway. For instance, the FSA Direct Farm Ownership loan offers up to 100% financing for those who wish to buy more family farmland, increase productivity or extend operations. There are also programs in place to ensure that farmland remains in the family for future generations. The U.S. Department of Agriculture's Farm Service Agency offers beginning farmer



guaranteed loan programs as a path-way to land and capital. Microloans also provide assistance during the early years of a start-up.

## FINDING THE LAND

Once the financial side is in order, it's time to search for suitable farmland. Begin by determining your long-term strategy. What will you plant or herd, and how much land is required? You'll need to analyze issues like irrigation, soil conditions, climate and location before making any purchase. Bring along

experts if you don't feel comfortable making those determinations yourself. A separate inventory of your farm equipment should also take place, in order to make sure you can continue to conduct operations without the need to purchase more. If you must buy additional larger machinery, there could be a significant impact on your budget.

## WHEN YOU BUY

Order a property-boundary survey before signing anything, so an expert can confirm that

the investment is legally theirs to sell. In some cases, neighbors may have been using land that didn't belong to them for long enough that the law might consider them owners. Attorneys can help resolve ownership, but that will mean additional costs and time. As with any other property transaction, be prepared to negotiate to get the best value. If you're not a natural negotiator, hire an experienced real estate agent with lots of experience in agricultural deals to complete the sale.



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# Farming in Schools

Outreach programs help educate our youth on the industry's importance.

The average young person probably doesn't think much about how food actually makes it to the dinner table. That's where initiatives like the National Farm to School Network and the Future Farmers of America organization come in. These programs educate our youth on the importance of farming, while encouraging interest in becoming part of the industry.

## FARM TO SCHOOL

The USDA sponsors the National Farm to School Network, aimed at increasing awareness of farming through food and agriculture education in classrooms and early-care centers. Communities are connected with local food producers through updated purchasing practices with a focus on local food in school cafeterias.

Sponsored educational activities related to agriculture, food and health also include farm visits, tastings, cooking demonstrations and the establishment of school gardens. Crucial commu-



nity connections are made with local farmers, providing healthier, locally sourced food while imparting invaluable lessons about our food system.

The similar IDEA CNP Farm Program works on a smaller scale, linking a network of 12 educational farms in Texas and Louisiana.

## FUTURE FARMERS

The Future Farmers of America organization was initially founded in 1928 to educate youths on agribusiness, production farming and forestry through leadership programs and intracurricular education. Their coursework and hands-on experiences have expanded more recently to encourage real-

world success in science, technology and business, so students can take part whether they intend to become farmers or work in other career fields. FFA members can also compete in career-development events focused on job skills, either individually or on a team.

## WHAT YOU CAN DO

Farmers and those interested in farming who'd like to have a positive impact on our youth can offer to help teach agriculture classes, sponsor their own after-school farm-focused programs, or become a regular guest speaker.

Found a new farming club, where young people can establish a school or community garden. Grow season-specific food, then harvest it and share with friends, family and the community.

Lead field trips back to your farm to explain more about the operation. Consider speaking to the school board about increasing their agricultural curriculum, as well as related conservation efforts like composting, tree planting and installing water catchments. Spearhead efforts to kick off a Farm to School program in your area, if there isn't one.

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# Effects of wildfires on commodity crops can be good or bad, but much remains up in the air

Jillian Ellison

Purdue News Service



The thick haze of Canadian wildfire smoke persistently blowing down into the United States throughout the month of June left many farmers turning to Dan Quinn for an answer to this common question: How will this poor air quality affect crop development?

Quinn, assistant professor of agronomy and Extension corn specialist, said he still finds himself offering the same answer: it depends, and it's complicated.

Some of the harm is more obvious, Quinn explains. Wildfire smoke blocks out the sunlight necessary for crops to photosynthesize. But the timing of the Canadian wildfire smoke occurred at an optimal period during the corn growth cycle.

"Between corn and soybeans, corn is a little more susceptible to reductions in light. The wildfire smoke came through in June when we were experiencing drought-like conditions, and a lot of crops were experiencing stress at that point," Quinn said. "Those reductions in light reduced leaf surface temperatures and transpiration off those plants, which alleviated some of that stress."

When corn experiences drought stress, its leaves will begin to roll inward, creating a semi-cylindrical shape. However, drought in soybeans isn't as visibly noticeable. Even though they are slightly more sensitive to carbon dioxide levels in the air in comparison to corn, Quinn said soybeans still saw some alleviation from drought stress due to the limitations on light.

Despite the temporary benefit in light reduction for crops, wildfire smoke still caused other harmful effects on crops and the environment.

Wildfires emit various air pollutants to form ozone when reacting with sunlight, Quinn said. Ozone can cause harm to both corn and soybeans by entering the plant through the stomata, which burns plant tissue during respiration.

Since reductions in sunlight and increases in ozone can cause photosynthesis reductions, corn may also remobilize carbohydrates from the stalks later in the season to satisfy grain fill requirements, thus increasing the potential for weak stalks and lodging prior to harvest. However, looking at this fall's harvest, Quinn

said expectations for yields are high despite the impact of wildfire smoke.

"The USDA is predicting record corn and soybean yields this fall for the state of Indiana, and much of that is thanks to the rainfall we've had throughout late July and August," Quinn said. "Crops were well established going into June, making the environmental hurdles we saw less detrimental. Had the wildfire smoke and drought conditions taken place, or even extended into July, we could have been having a totally different conversation."

With wildfires becoming more

common with climate change, Quinn said this where his "it's complicated" answer comes into play for farmers questioning how toxic air affects their crops.

"It's complicated because we see both the positive and the negative impacts, and trying to quantify that is a challenge," Quinn said. "There are so many different components at play that can create harm to the crops, and it's hard to tell what is specifically due to wildfire smoke rather than other environmental factors."



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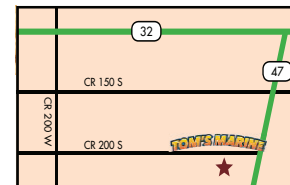
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# Purdue researcher's short corn has far-reaching potential for growers, industry and the environment

**Nancy Alexander**  
Purdue News Service

Gurmukh (Guri) Johal is a scientist, not a teller of fairy tales. But the Purdue professor of botany and plant pathology likens his recently patented genetic mutation in corn to “Goldilocks and the Three Bears.” Like the girl’s three tries to find the perfect porridge, chair and bed, Johal tried two other mutations on his 35-year path to high-yield dwarf corn before discovering the one he says is “just right.”

“I found the Goldilocks mutation in 2020 when Covid started,” Johal says. “So we could not do research in the lab and that year could not hire anybody to work in the field. I was doing everything on my own. Then I found this mutant in the field — I’d never seen anything like it before. That was my aha moment.”

This short corn variant, D16, generates a hybrid plant optimal in both height and vigor, he says.

Johal’s focus on the mechanism of dwarfing in corn dates to 1988, when he was a postdoctoral researcher with Pioneer Hi Bred Seed Company (now Corteva). “That’s where we cloned the first gene for disease resistance ever in plants, which happened to be in corn,” he says. That particular gene was closely linked to the brachytic2 (br2) mutation, which the researchers used as a genetic marker to clone the gene for disease resistance.

“Brachysm” refers to dwarfing in plants in which only the internode — the plant stem between two nodes from which leaves emerge — are shortened. The work sparked Johal’s interest in plant height regulation and architecture. “Definitely disease resistance is very important, but height is important as well,” he says.

A short corn variant could benefit farmers, industry and the environment. Based on its financial potential, D16 has attracted interest from several large

agribusinesses, for obvious reasons: U.S. farmers plant 90 million acres of corn annually. The trait is non-GMO so can be planted worldwide and, when permitted, can be easily introduced into any elite line by gene editing.

“This trait has the potential to impact the entire crop of corn in the U.S. and beyond,” Johal says.

In working toward D16, his research increased understanding of two other corn-dwarfing mutations. In 1995 he began working with anther ear 1 (an1), a gene in the same pathway that rice and wheat breeders, including Norman Borlaug, used to make dwarf varieties in the 1960s. These were key to the Green Revolution of the late 1960s, heading off famine on the Indian subcontinent and in Southeast Asia.

But corn isn’t like rice and wheat, Johal explains. “In the 1960s when people were working on rice and wheat and were very successful there, people did try it on corn. But they did not find anything that was just right, so they kind of gave up on it.”

Johal’s own research with an1 resulted in dwarf corn, but of variable height. He showed that the mechanism that worked in wheat and rice — a limitation in the pathway that leads to the production of the plant hormone gibberellic acid — didn’t work in corn because it impacted the differentiation of male and female sexes of flowers.

Johal next focused on the brachytic2 (br2) mutation of maize. Although br2 was first identified in 1951, scientists did not understand its underlying genetic mechanism until Johal and his research team published their results in the journal *Science* in 2003. “We showed why plants that had the brachytic2 mutation were short,” he says.

Johal’s team cloned and patented the br2 gene in 2002 in collaboration with Pioneer. Once the patent expired, other companies began applying the brachytic2 mutation to reduce the height and



generate what they called smart, or short, corn.

But plant breeders didn’t get it just right, either. “Corn, unlike all other plant species, has two aspects of plant height,” Johal explains. “One is the overall height. The second is the height of the ear.” These seemed to conflict with each other, he adds: Shortening the overall plant height lowers the ear too far; bringing the ear up mitigates against the short stature of the plant.

“Working with these mutations, it became clear to me that the only way we can generate short corn plants that would be commercially viable and very beneficial, would be if the mutation were dominant, so it has to be in only one of the two inbred lines used to make hybrid plants,” Johal says. “And secondly, it has to make a plant not too tall and not too short. But that window of height range is very narrow.”

His D16 mutant reduces corn from 9-10 feet in height to 6.5-7 feet, which keeps the ear at a height that can be harvested mechanically with a standard U.S. combine.

Since the 1960s, corn breeders have increased yield by developing germplasm that allows plants to be grown closer together. “Some people think there’s still potential to increase density,” Johal says. “But to be able to realize that potential, we first must bring the height of the plant down. Tall and dense plants become vulnerable to wind dam-

age. This domino effect basically causes the entire crop to fall down.”

Short corn’s durability in wind is especially important as climate change increases the frequency of high-speed Midwest storms called derechos. In 2020, a derecho flattened 2 million acres of corn in Iowa alone, causing \$8 billion in damage. Growers lost not just their crops; costly inputs like fertilizer, fungicide and water all went to waste.

Financial impact and environmental impact “go hand in hand,” Johal says. He cites fertilizer as an example. Normal hybrids get so tall so quickly that farmers have to provide fertilizer at the time of planting, he notes. “But plants use very little of it early on; they need it later.” In the meantime, much of the fertilizer runs off or degrades. “If farmers can provide this crop fertilizer at later stages, we would need less fertilizer,” he says.

The D16 mutation offers this possibility, he says. And because dwarf corn allows for more plants per acre, Johal believes it may allow growers to use less land, which means less energy, fertilizer, water and other expenses.

He cites a hypothetical situation: “If you have 1,000 acres of land — but only 300 acres of that land is really the best for planting — only use that much. Put your best genetics in there and give it the utmost attention and treatment, then you probably can get more from those 300 acres than the entire 1,000 acres. So then 700 acres can be left to nature.”

When Johal drives through current cornfields he envisions that balance of agricultural crops and nature — fields interspersed with forested land, especially in low-lying areas, and all the benefits of more trees, including wildlife habitat and carbon dioxide capture.

And when you come to a rural intersection in Indiana, he notes, you’ll be able to see around the short corn.

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# Experiments identify important new role of chemical compounds in plant development

**Steve Koppes**  
Purdue News Service

Researchers who manipulate lignin, a molecular fiber that allows plants to grow tall and transport water, unexpectedly discovered its synthesis has more far-reaching effects on plant development than previously suspected.

“My lab has had a long interest in studying the extent to which we can modify plants, specifically the lignin biosynthetic pathway,” said Clint Chapple, Distinguished Professor of Biochemistry at Purdue University. “Of all of the components that make up the plant body, lignin is the one that’s easiest to manipulate. And it has an impact. The pulp and paper process is really about removing lignin.”

Lignin also affects the quality of animal feedstocks and of plant biomass to produce biofuels. “We’ve had some significant success with it over the years. But we ran into a set of observations that we couldn’t explain,” Chapple said.

Chapple’s team genetically engineered the flow of chemical precursors that feed the pathway leading to lignin biosynthesis in *Arabidopsis thaliana*, a widely used experimental plant species.

“When we took two strategies that worked quite well on their own and combined them, instead of getting a synergistic effect, we got plants that were only a few inches tall. And we were really puzzled by that,” Chapple recalled.

Researchers proposed four main ideas to explain this phenomenon. “There was a lot of uncertainty over which one, or ones, were correct,” said Fabiola Muro-Villanueva, who earned her PhD in biochemistry at Purdue in 2020.

To learn more, Muro-Villanueva spent several years conducting laborious experiments, testing the effect

of various plant-derived chemicals on thousands of plants. In the end, she found a way to restore growth to the plants by providing a compound called pinoresinol. Muro-Villanueva, Chapple and nine co-authors from Purdue and elsewhere published their findings in the journal *Proceedings of the National Academy of Sciences*.

“It seems to be a hormone-like growth compound,” said Muro-Villanueva, now a postdoctoral fellow in molecular and cellular biology at Harvard University.

In the work’s early stages, Muro-Villanueva observed changes in the plants’ production of lateral roots, the branches that make up the root system. And they had changes in the production of root hairs, which are important for water absorption.

“Those are aspects of plant development that don’t really have very much to do with lignin,” Chapple said.

The researchers added back to the plants a compound called coniferyl alcohol, a key precursor compound to lignin formation. This resulted in root hairs that grew big and normal instead of short and deformed-looking.

“That was really very unexpected,” Chapple noted. “It seems that there’s some function for these compounds in plants that we hadn’t appreciated before.”

Until now, plant scientists had widely assumed that pinoresinol serves only as a lignin building block. “Our evidence shows that it’s more than just replacing a building block in lignin. We don’t know the mechanism, but we think there is a much bigger story here,” Muro-Villanueva said.

The findings add new insights to the long list of plant capabilities.

“Plants are excellent chemists. They make a wide variety of compounds that are intrinsically interesting,” Chapple said. Collectively, they make hundreds of thousands of com-

pounds, although individually they often specialize in specific compounds we associate with particular plants.

“They perform many functions. They allow the plant to resist ultraviolet light. So basically, plants make their own sunscreen,” he said. They also deter insect and bacterial attack. And from a human perspective, some of these compounds give our food flavor or aroma, while others provide medicinal properties.

“This is basic research,” Chapple said. “But if we are to move biofuels forward with manipulation of plants to optimize those processes, it’s important that we have a thorough understanding of the roles these pathways and chemicals have in plant development.”

Otherwise, he fears that researchers could put a newly developed variety into the field only to see it fail to perform as expected because they lack a critical understanding of what they can and cannot do with critical biosynthesis pathways.

“We need to have a better understanding of how plants perceive and respond to these compounds,” Chapple said. “And how does their absence lead to these dwarfing effects and alterations in root development?”

This study was supported by the Direct Catalytic Conversion of Biomass to Biofuels (C3Bio), an Energy Frontier Research Center funded by the U.S. Department of Energy’s Office of Science.



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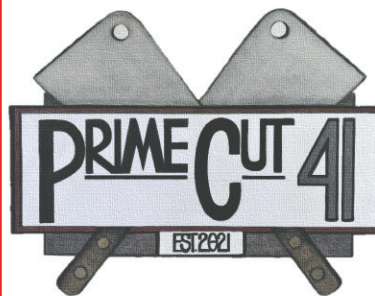
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