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# CROP INVADERS

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**THESE NEMATODES EAT  
ROOTWORMS FOR BREAKFAST**

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**NEW TOOLS BATTLE  
WHITE MOLD**

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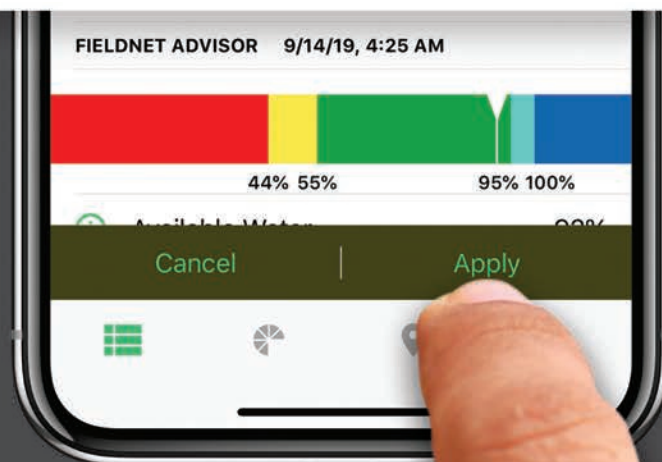
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# SPECIAL ISSUE

## MID-FEBRUARY 2020

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Serving Our Readers Since 1886

# CROP INVADERS

## ABOUT THE ISSUE

### BATTLE LINES DRAWN

*Some intruders in your fields are to be feared, some celebrated. In either case, thorough management practices can make the difference in the war against yield robbers.*

*Cover Illustration by Barry Falkner*



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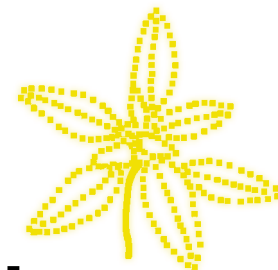
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— Erin Holbert, Indiana producer





# The Good, the Bad And the Interesting Invaders



**Pamela Smith**  
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Last summer, I spent a few days at a children's writing workshop. One creativity exercise involved a hike during which we were to gather a nature specimen and describe it.

The fact that I plucked common chickweed along the garden path shouldn't come as a big surprise. My dissertation (errr ... description) began: "It's a winter annual easily controlled by fall or early-spring burndown herbicides. It can form dense mats that can slow drying and warming of soil in the spring. It is one of several winter annuals that can serve as an alternative host for soybean cyst nematode (SCN) ... "

I looked up during this delivery to see the dazed looks and frowns on the faces of other workshop participants. Oops, leave it to an ag journalist to literally get lost in the weeds. Yeah, I might have listed the best herbicide tank mixes for control, too.

In agriculture, we often see invaders as threats, and we take them seriously. In this issue, you'll find articles detailing some longtime troublemakers such as Western corn rootworm and soybean white mold.

We've taken a lot of space to talk about SCN since it sneakily robs soybean growers of yield each year. And, as a recent survey by DTN shows, we are falling short on the "take-the-test, beat-the-pest" challenge. Our polls showed 40% of respondents have never soil-sampled for SCN, the first and very critical step in fighting back.

However, one thing we also discovered writing this special issue focused on crop invaders is they aren't all bad guys. In fact, some of these invaders do good work and even lend themselves to fairly descriptive terms. Prepare to go "ewwww" when you read about "liquefied larval guts" in Emily Unglesbee's article on beneficial nematodes that invade corn rootworms ("Invasion of the Rootworm Snatchers," on page 8).

For all of these articles, we leaned heavily on scientists working on the many good, bad and very interesting invading pests in agriculture today. Farmers may sometimes

## Soybean Cyst Nematode Poll

**Do you or does anyone else currently scout or soil-sample for soybean cyst nematode (SCN) in your fields?**

<b>Yes</b>	<b>27%</b>
<b>Never</b>	<b>40%</b>
<b>I have, but it has been more than three years ago.</b>	<b>32%</b>

Total Responses: 273  
Poll may not equal 100% due to rounding.  
Source: DTN/PF Ag Poll

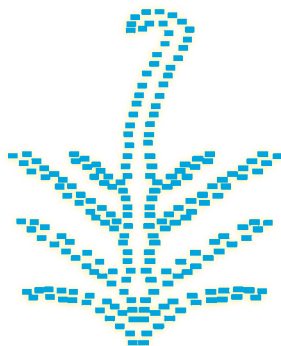
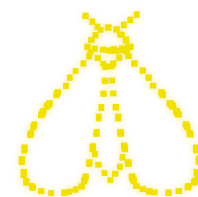
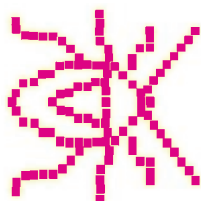
question the practicality of research, but the passion and pursuit of answers by university and public scientists really show when new invaders such as soybean gall midge, tar spot, cotton leafroll dwarf virus and others come to call. Finding answers to these complex problems is far from simple or absolute.

Another thing we realize is that we've barely scratched the surface of all the invaders farmers face each year. I've got a laundry list of "we need to cover" topics leftover.

If we didn't include a pest or problem that's been particularly vexing to you, let us know. As service journalists, that's what we love to do—dig in and invade topics that matter.



CROPS TECHNOLOGY EDITOR





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# INVASION

## OF THE ROOTWORM SNATCHERS

*These nematodes eat insect guts for breakfast. Can they save Bt corn?*

**There's a sci-fi horror movie playing out beneath** Gary Frost's corn fields in the Texas Panhandle.

It all started in the spring of 2017. Under the cover of nightfall, scientists sprayed water teeming with tiny, juvenile nematodes into 2 acres of dense, black soils on his northern-Texas farm.

The microscopic invaders immediately went to work.

First, they wormed their way into their favorite victims—fat, yellow, soil-dwelling larvae of the Western corn rootworm. Once inside, the nematodes regurgitated a bacteria that poisons the larval host and dissolves its innards.

Now, it's time for the nematodes to feast. They suck up the liquefied larval guts and use the newfound energy to reproduce. Soon, up to 50,000 tiny new juveniles swarm and wiggle inside the crusted dead shell of the larval victim. At last, the corpse splits open like a croissant, and in a warm, butterlike gush of fluid, the baby nematodes are unleashed into the soil. Some will hunt more prey immediately. Others will lie dormant for one to three years before waking up and restarting the ghoulish process.

Before you run screaming in terror, meet the mad scientist behind these soil invaders: Elson Shields, an Extension entomologist at Cornell University, who promises the nematodes are a force for good.

These microscopic worms, known as entomopathogenic nematodes, have been used as biocontrol tools for soil-dwelling insects in the past in other industries, such as horticultural crop production. With his rootworm-munching populations, Shields hopes to make them an option for corn growers who are battling Western corn rootworm, a pest that has evolved resistance to every Bt toxin deployed against it and can cost growers up to \$2 billion a year, according to government estimates.

"They're a completely independent mortality factor that could extend the usefulness of our GMOs, soil insecticides and other rootworm-management strategies," Shields says.

Texas farmer, Frost, is inclined to agree. Where corn plants once used to lean and curve "like a bow and arrow" from the rootworm feeding, they now stand rod straight, and root digs show minimal damage, he explains. Since that initial 2-acre experiment, he opted to inoculate 238 acres of his farm with more nematodes last year.

### FROM NEW YORK TO TEXAS

Shields initially got into the nematode game to help farmers control the alfalfa snout beetle, which had been devastating alfalfa crops in upstate New York since

*Scientists huddle with Gary Frost during a nighttime application of nematodes on his Texas farm.*

the 1920s. Once the scientists finally discovered the right species of beetle-guzzling nematodes, they started testing them to see how long the nematodes would persist in the soil.

“We have over 20,000 acres that have been inoculated by farmers in New York,” Shields says. “After 10 years and 55,000 soil samples, we got tired of looking. They’re still there, and it appears a single inoculation is all it takes.”

In the process of testing how well these nematodes survived when farmers rotated away from alfalfa to another crop, Shields and Cornell researcher, Antonio Testa, noticed something strange.

“We saw an increase in the nematode populations in second-year corn rotations,” Shields recalls. “We realized they must have activity on corn rootworm, too.”

Starting in 2014, Shields and his team planted plots with non-Bt corn, nematode-inoculated non-Bt corn and three separate Bt corn technologies: Cry3Bb1 (YieldGard), Cry34/35 (Herculex RW) and a pyramided variety with both proteins (SmartStax). For two years, rootworm populations remained too low for much data. Then in 2016, populations swelled. The conventional corn in Shields’ plots showed a damaging root injury rating of 1.9 (the scale goes from 1 to 3, with each number representing another node eaten—and ever greater yield losses).

Shields’ nematodes kept root injury ratings on their non-Bt corn roots down to 0.2, as well as any of the Bt toxins.

Texas A&M Extension entomologist Pat Porter was impressed with Shields’ results. Western corn rootworm infestations have long spread beyond the Corn Belt, and corn growers throughout the Texas Panhandle are struggling to control populations with suspected resistance to mCry3A (Agrisure RW), the primary rootworm Bt trait in many corn silage hybrids.

Texas scientists asked Shields to send some of his New York nematodes down to the Panhandle to experiment on Frost’s infested fields near Dalhart in 2017. They



PATRICK PORTER, TEXAS A&M

inoculated 2 acres of a continuous corn field planted to non-Bt corn. It was a lot of pressure for his nematodes, and Shields was a little worried.

“We usually don’t get the best results in year one; it usually takes two to three years for nematode populations to build enough,” Shields says. “And, this was an extremely high rootworm population.”

The untreated acres showed high rootworm injury ratings of 2.5 to 2.7 that year. “The corn was basically flat,” Shields recalls. But, the nematodes pushed back root injury on their acres to 1.5 in just a single season.

Frost was thrilled but wondered if the nematodes would survive in their new Texas home. Soil core tests prove they have established healthy populations each year, probably thanks to abundant rootworm buffets in the soil, Porter says. ➤



*The cups of nematodes (left) from Cornell University each hold about 25 million juvenile nematodes packed into wax worm larvae for the long trip from New York to Texas. Farmer Gary Frost (below, left) and nematode developer Elson Shields talk as nematodes wait in their containers before the inoculation.*



PHOTOS: PATRICK PORTER, TEXAS A&M



PATRICK PORTER, TEXAS A&M

Scientists take soil core samples to test for nematode persistence in the soil.

“The takeaway is these liberal northeast New York nematodes can survive in bright red Texas and persist there for three years,” Shields jokes.

After presenting his findings to a group of growers in southeastern New Mexico last January, Shields was invited to inoculate another 900 acres near Roswell, New Mexico. He estimates that at least 23 billion of his New York nematodes are now residing in the southwest U.S.

### NEMATODES SLEEP IN

In the spring of 2019, Shields’ nematodes made their 1,700-mile trip to Texas packed into boxes of sawdust and dead wax moth larvae in the back of his 2009 Chevy pickup. A generator ran continuously to power a window air-conditioning unit in the tailgate, which kept the truck bed at a pleasant 70°F—the nematodes’ preferred temperature.

Starting at dusk to accommodate the nematodes’ sensitivity to UV light, a team of entomologists worked alongside Frost until 3 a.m., using a commercial sprayer to disperse nematode-infested water onto more than 200 acres.

The scientists have continued to tweak and experiment with application methods. Later that spring, scientists in New Mexico applied the nematodes to fields in broad daylight through a center pivot, with just as much success in survival and establishment of the nematodes.

Around 30% of the applied nematodes immediately go to work hunting rootworm larvae and breeding, Shields says. But, the other two-thirds will lie dormant, some for two years, some for three years. Then, they will wake up and take over. This is a strategic trick of evolution that allows his nematodes to persist not just

for an entire year but for at least a decade and likely longer, Shields says.

He worked hard to keep the genes for this dormancy trait, called delayed infectivity, in his cultivated nematode populations. That’s why the New York alfalfa farmers and Frost will probably get by with a single inoculation.

It’s a great strategy for farmers but less appealing to commercial companies. Most commercially available nematodes haven’t maintained this evolutionary trait, and companies sell new populations to growers each year. Shields’ nematodes promise to be far less

lucrative a prospect. “Commercial nematode producers are not interested in producing a nematode they only sell once,” he notes.

Shields estimates the cost of inoculation at \$35 to \$100 per acre, depending on the density of nematodes a grower selects. “A lot of the cost depends on how impatient a farmer is and if they are willing to give it a couple years to start working,” he says.

So far, research applications have relied on state and university funding, as well as some private funding from local industry groups, such as the Texas Corn Producers Board. Entomologists from Alabama, Michigan, Pennsylvania and Vermont have launched trials to test Shields’ nematodes, mostly against rootworm but also other pests, such as billbugs.

**“I have said from the get-go that this is a technology that can be used to strengthen other management techniques.”**

—Eelson Shields

Rootworms could theoretically develop resistance to nematodes, just as they have Bt traits and crop rotation, which is partly why Shields has no grand ambitions for his nematodes to unseat any current rootworm-control methods. Rather, he hopes they could lengthen the lifespan of Bt traits and insecticide options by killing Bt-toxin survivors and then lingering in the soil, ready to act should rootworm numbers rise again, Shields says.

“I have said from the get-go that this is a technology that can be used to strengthen other management techniques,” he says. ///



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PAMELA SMITH

*Some diseases that favor extreme weather conditions, such as sudden death syndrome, may become more prominent because of weather extremes.*

### THE EXTREMISTS

Sudden death syndrome is well-known for highly visible interveinal yellowing and necrosis that occurs during soybean reproductive stages.

The fungus, *Fusarium virguliforme*, thrives in cool, wet soils and infects plants' roots during the seedling stage of development. When rainfall events occur later in the season during early to

mid-reproductive stages, a toxin caused by the disease is flushed up into the plant, causing the dramatic symptoms and yield loss.

"It is now a major disease in most soybean-growing areas," Mueller says.

Physoderma brown spot in corn is caused by a fungus called *Physoderma maydis*. The polka-dot-like symptoms were common in 2019 because of the early monsoonlike rains that swept much of the Corn Belt.

The infection starts very early in the season, when swimming spores enter the whorl of the corn plant during heavy rainfall and flooding, most often between the V5 and V9 growth stages. The fungus causes lesions to form on the leaves and stalks. If it infects nodes 6 and 7, the disease can also lead to a stalk rot later in the season.

Look for charcoal rot in soybeans during hot, dry seasons. Tiny structures called microsclerotia grow inside the taproot and stems, clogging the plant's ability to move nutrients and water, and causing them to turn yellow and brown, and wilt. Plant pathologists expect charcoal rot to become more prominent as dry growing seasons become more common, Mueller explains.

"Extreme examples—one too much water, one too little water—and there are diseases ready for either condition," he says.

### THRIPS THREAT

Thrips love heat. These plant-sucking pests prefer to reproduce when temperatures rise into the 80s and do best in dry conditions. Thrips bleed precious moisture from plants, and they vector viruses such as soybean vein necrosis virus, tobacco ringspot virus and tobacco streak virus. Between 2013 and 2017, plant pathologists

# Hot Mess Pests

*Weather extremes can heighten insect and disease threats.*

**Weather extremes are a double threat to row crops**, as some insects and diseases thrive in the chaos of flooding, drought, hail and heavy rainfalls.

Diseases that prefer overly wet seasons, such as sudden death syndrome (SDS) and *Physoderma* brown spot, or overly dry seasons, such as charcoal rot, are posing greater challenges, says Iowa State University Extension plant pathologist Daren Mueller.

He sees heat-loving insects, such as thrips and the diseases they vector, on the rise. Traditionally, southern problems, such as corn rust and frogeye leafspot are moving northward. Diseases with origins in equatorial regions and the Southern Hemisphere, like tar spot and bacterial leaf streak in corn, are suddenly surfacing in the Midwest.

The development and life cycles of diseases and insects are notoriously complex. Many factors influence their rise and fall, from economic pressures to evolving pest-management and farming practices, Mueller stresses. However, several are real opportunists of climate change.



*Stalk breakage can occur when the *Physoderma* brown spot fungus infects corn nodes.*

DAREN MUELLER, IOWA STATE UNIVERSITY



*One trick to confirming tar spot lesions on corn? The shiny black dots won't scrape off the leaf.*

MARTIN CHILVERS, MICHIGAN STATE UNIVERSITY

have seen outbreaks of these viral diseases—a good indicator that thrips are doing very well, Mueller notes.

In contrast, viral diseases vectored by the soybean aphid, such as the soybean mosaic virus, have been on the decline. One factor seems to be that soybean aphids do not do well in hot, dry conditions. Their reproductive abilities slow dramatically as temperatures push into the upper 80s, and they die within days when temperatures surpass 95°F, Mueller says.

### REGION ON THE RISE

Southern corn rust has been defying its name in recent years, sneaking into the Midwest as early as July to infect corn fields and threaten yield loss.

The disease usually gets its start each year in Mexico and the Caribbean, but the disease may now be overwintering farther north. Plant pathologists have responded by creating a tracking tool to help growers stay aware of the fast-moving disease: [corn.ipmpipe.org/southerncornrust](http://corn.ipmpipe.org/southerncornrust).

Likewise, frog-eye leafspot, long the bane of Southern soybean growers, is becoming a regular visitor in the Midwest, Mueller continues.

### THE GLOBE-TROTTERS

You have to look even farther south to find the origins of two new invaders—tar spot of corn and bacterial leaf streak of corn.

Tar spot of corn was first discovered in the U.S. in 2015 in Illinois and Indiana, and has since been documented in eight states, where it can cause serious yield losses in susceptible varieties. The disease was previously only found in the Caribbean, Central America, Mexico and South America.

Likewise, bacterial leaf streak of corn surfaced in Nebraska in 2013 and has since been found in nine other states. The bacteria that causes the disease, *Xanthomonas vasicola*, was previously most common in the Southern Hemisphere, in places like Africa, Australia, the Caribbean and Central America.

How are these distant southern invaders getting here? Scientists are still hunting for answers to this question, but one prominent theory is that they may be moving north on the increasingly severe tropical storms that form near the equator in the Atlantic Ocean and besiege North America each year, Mueller notes. ///



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# White Mold Defense

*New tools help fend off the yield hits.*

MARTIN CHILVERS, MICHIGAN STATE UNIVERSITY

**Marlin Fay has a simple descriptor for white mold.** “It’s ugly!”

The Grand Meadow, Minnesota, farmer has been fighting the fungi for the past six years. Disease pressure has been significantly worse the past four years, especially on long-manured fields.

One tree-lined field has become such a challenge that it is now a favorite location for the local CHS cooperative to run test plots to evaluate soybean varieties for tolerance issues.

“I plant in 30-inch rows and have dropped my seeding rate from 175,000 to 140,000, and may go to 125,000 seeds per acre,” Fay says. “I look for resistance when selecting seed.”

New tactics such as Sporecaster, an app designed to better pinpoint application timing of control products, offer future hope. Soybean research is also unlocking disease secrets to help in the fight.

## CONFUSION ABOUT RATINGS

One stumbling block growers face is the resistance ratings used by most commercial seed companies. Lack of a common standard makes comparisons nearly impossible.

“We carry four brands, and the ratings have different values on each,” notes Fay’s seed adviser, Tim Gehling, manager, CHS (Rochester) Seed. “However, with our local plots, we can evaluate them and select the

right package for our members, depending on risk. I look for a combination of characteristics, including resistance, standability and branch structure.”

*A fingernail-sized sclerotium can produce multiple apothecia, each of which can release 3 million or more spores. Spores infect the plant by landing on a soybean flower, germinating and initiating white mold infection.*

Tom Oswald has been fighting white mold on his Cleghorn, Iowa, farm since the early 1990s. He’s watched fields yielding 70 bushels per acre (bpa) drop to 30 bpa where white mold is a problem. Introduction of resistant varieties has helped, but sometimes it takes time to show up in new herbicide trait platforms.

Oswald has been tempted to move to narrow row widths but hesitates due to white mold concerns. “Wider rows do help dry out the canopy some, but I’ve seen 30-inch fields devastated, as well,” Oswald says.

“In 2017, we were dry for eight weeks, which reduced white mold potential but also potential yield. Then, it started raining in August, and the soybeans responded, but so did the white mold.”

## TREATMENT OPTIONS

Fungicides can help with control, but timing is everything, Oswald explains. “You never know you have white mold until after you have it,” he says. “In these economic conditions, the extra cost of two applications, >



# PERFORM.

**KEVIN KALB**  
DUBOIS, INDIANA



NCGA YIELD CONTEST NATIONAL WINS

minimum at \$40 an acre, can be hard to swallow if white mold doesn't develop."

It's erratic nature also makes it a hard disease to research, University of Minnesota plant pathologist Dean Malvick notes. "This past season, we put out trials

of products in fields with a strong white mold history on eight farms around the state. We only had enough white mold at one to see an effect," he says.

Even if the right conditions are present for white mold to be present, a fungicide has to be applied before the infection starts.

"If the infection

has started, there isn't much that a fungicide can do to stop it," Malvick says.

He hopes Sporecaster can help. Its mathematical model evaluates field data, such as planting dates, row widths, variety, irrigation or dryland, row closure and weather. The model projects the risk of white mold developing and the potential return with a fungicide application. App users input whether plants are flowering and if rows have reached 40% of closure. It correlates that information with stored data and weather data for the past 30 days.

"What is given is a probability of risk for the location of zero to 100%," says Damon Smith, University of Wisconsin field crops pathologist. "If 40% or higher (in dryland), a fungicide application is recommended."

Sporecaster was developed at the University of Wisconsin, validated there and in neighboring states, as well as in Michigan, and released in 2018. Currently, it has been downloaded more than 3,000 times with good evaluations and generally positive results. An exception was northwest Iowa, where Oswald tried it.

*White fungal growth is ugly. Once cottony mycelium aggregate the hard, black sclerotia that form on and in infected plant tissue, they can stay in the soil for a decade or more waiting to germinate.* MARTIN CHILVERS, MICHIGAN STATE UNIVERSITY



*White mold drives many of Tom Oswald's soybean-production decisions as he tries to control it economically.*

MATTHEW WILDE

"It never flagged the need to spray, and we had bad mold," he says.

"It was the mathematical model we used," Smith adds. "In the model we developed, wind speed, which can dry out the plants, is one of the parameters and inversely related to prediction. However, the humidity was high enough to push white mold, but the wind speed hid that."

Smith and fellow researchers are already evaluating models to better reflect different areas and conditions. Sporecaster is designed to work in the northern U.S. and Canada.

## RESEARCH INSIGHTS

The 30 days before infection are very important for this disease. For white mold to develop, sclerotia (the dormant stage of the fungus) must be present. Weather conditions must be right for them to germinate and produce apothecia, the tiny mushrooms that release spores that infect the plants.

If the sclerotia don't germinate, they can remain in the soil for up to 10 years, perhaps longer. This is why a hot spot can randomly flare one year but not another.

Smith, Malvick and other pathologists in the North Central Soybean Research Program are exploring other avenues of control, including germplasm, which recognizes it is being infected and puts up an active defense through the production of antifungals. They have also identified how the infection hijacks the normal production of oxidative compounds, using them to fuel the infection.

The Wisconsin team has patented a process to

prevent this takeover, one which has the added benefit of enhanced drought tolerance. The problem is getting these benefits into commercial seed.

"While the enhanced resistance is now available in public soybean varieties, it has not been added to traited varieties by the commercial seed companies," Smith notes.

Other naturally occurring compounds that attack the pathogen and interfere with fungal growth are also being explored. The knowledge is being applied to better understand resistance. Oswald applauds any and all new tools, and he endorses the use of soybean checkoff funds to support their development.

"Anything that can help reduce white mold pressure is worth trying," he says. ///



# PRODUCE.

**DREW HAINES**  
MIDDLETOWN, MARYLAND



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# The Dirt On Rootworms

*This corn pest may be lying low, but it remains a big threat to growers.*



JOSEPH L. SPENCER, UNIVERSITY OF ILLINOIS

**For more than two decades, Joe Spencer has** spent many a summer evening standing atop 30-foot-tall towers above corn fields, trying to catch adult Western corn rootworm beetles as they buzz by looking for a place to lay eggs.

Lately, he's been a little lonely up there.

"Populations are pretty low right now," says the University of Illinois entomologist, who works for the Illinois Natural History Survey. Widespread rainfall during rootworm egg hatch in June 2015 led to a major collapse in many Corn Belt rootworm populations.

Spencer is worried the lull in rootworm feeding might lure growers into a feeling of false security. After all, this is a pest that cost the industry up to \$2 billion a year at its peak. Moreover, when it does surface in fields, the rootworm is increasingly problematic, Spencer says. It has evolved resistance to all four of the Bt traits on the market that target it, and new technology is still at least a couple of years down the road.

## RESISTANCE IS GROWING

Cry3Bb1 (YieldGard RW) was the first Bt protein on the market to target rootworm

*Net in hand, Spencer stands in front of one of his 30-foot towers, which he scales each summer to track rootworm beetle populations.*

back in 2003. It was followed a few years later by Cry34/35Ab1 (Herculex RW) and mCry3A (Agrisure RW). Industry soon began stacking mCry3A or Cry3Bb1 with Cry34/35Ab1 to create pyramided hybrids with two modes of action. In 2014, a fourth Bt protein, eCry3.1Ab, was added to the landscape and pyramided with mCry3A (Agrisure Duracade).

One by one, Western corn rootworm began developing resistance to each trait. First, in 2009, Iowa State University entomologist Aaron Gassmann collected rootworm populations in Iowa that were surviving the Cry3Bb1 toxin. By 2011, Gassmann had also collected populations that could survive mCry3A, and he documented that they had cross-resistance—meaning a Cry3Bb1-resistant rootworm would also be resistant to mCry3A and vice versa.

Because of its structural similarities to the other Cry3 traits, cross-resistance to eCry3.1Ab (Duracade) was found almost immediately after it was commercialized. By 2016, scientists from Iowa and Minnesota confirmed field populations of rootworm that were resistant to eCry3.1Ab, as well as the other Cry3 traits.

Now, resistance to these three Bt traits is fairly commonplace, Spencer says. "From what I've seen from all the testing over the years, there is very little susceptibility to the Cry3 traits—Cry3Bb1, >



EMILY UNGLESBEE



# PRE VAIL.

**HEATH CUTRELL**  
CHESAPEAKE, VIRGINIA



NCGA YIELD CONTEST NATIONAL WINS

## THE MANY FACES OF CORN ROOTWORM

Here's a quick review of the two major types of rootworms Midwest farmers face today:

**WESTERN CORN ROOTWORM (WCR):** This is the dominant rootworm species in the Midwest and Great Plains. Adult beetles have a yellow body with black or black-striped wing covers. In addition to Bt-resistant populations, the WCR has one other variant population:

**Rotation-resistant:** This type of WCR has evolved to outsmart the traditional corn-soybean rotation by laying its eggs both in corn and in neighboring fields, usually soybeans. When first-year corn is then planted to those fields, the rootworm eggs are waiting in the soil. Like other Western corn rootworms, this variant's populations have remained low recently, but it has been problematic in parts of Illinois, Indiana, Iowa and other Midwestern states in the past, Spencer notes.



PAMELA SMITH



JOSEPH L. SPENCER, UNIVERSITY OF ILLINOIS

**NORTHERN CORN ROOTWORM (NCR):** This was the original native rootworm found in the Midwest, but WCR moved eastward during the mid-20th century and became the dominant Midwest species. As the more cold-hardy rootworm species, NCR has remained abundant in the northern Corn Belt, Spencer says. It may be seeing a resurgence recently, as some reports of NCR surviving in Bt corn fields have been surfacing, he warns. Adult beetles of NCR are smaller than WCR, with wing covers solidly colored and ranging from light tan to pale green. Like WCR, Northern corn rootworms have one variant that outsmarts crop rotation:

**Extended Diapause:** When this type of NCR lays eggs, a certain percentage do not hatch the first year and instead lie dormant through the subsequent soybean crop before hatching in the second year, when a corn crop is planted once again.

mCry3A and eCry3.1Ab,” he says. “And, due to cross-resistance, insects that are resistant to one are resistant to all three.”

Cry34/35Ab1 fared better until recently, when Gassmann confirmed partial resistance to the trait in Iowa rootworm populations in 2016 and full resistance in 2018.

That is a deeply concerning development for corn growers since most pyramided Bt corn hybrids on the market rely on Cry34/35Ab1 for efficacy against the Western corn rootworm, Spencer warns.

“Pyramids with Cry34/35Ab1 are planted over a large area, and a lot of rootworms are exposed to it,” he says. “That’s putting a lot of pressure on this trait.”

“There is more resistance continuing to develop,” he adds. “When I do bioassays, I get 20 to 30% survival on this trait, and that’s to be expected. Insects have been exposed to this product since 2005.”

### WHAT'S NEXT

Growers have been waiting a long time for the next generation of rootworm traits from the industry. So far, the only new mode of action on the horizon is Bayer’s SmartStax PRO, which uses RNA-interference

technology to target the rootworm, in addition to Bt toxins.

Once a SmartStax PRO hybrid is ingested by a rootworm, the new RNAi trait switches off a gene in the rootworm’s DNA, which halts the production of a key protein and kills the insect.

The RNAi trait has made its way through the U.S. regulatory system but remains in limbo as it waits for import approvals from two key export markets, the EU and China, says John Fietsam, Bayer’s corn systems lead for North America.

“We’re targeting a commercial launch in the U.S. market early in the next decade,” Fietsam says. SmartStax PRO hybrids would contain three rootworm traits: Cry3Bb1, Cry34/35Ab1 and the new RNAi trait. They would be sold as 5% Refuge-in-a-Bag products.

Spencer hopes Cry34/35Ab1-based hybrids can keep up the fight until then.

“In many places, it’s the only trait out there providing protection,” he notes. “But, I think a lot of growers are getting good advice now thanks to new rootworm-monitoring programs, and they’re thinking twice about using Bt when they don’t need it—and hopefully helping to preserve the efficacy of this Bt trait.” ///



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DKC67-44 Brand

Jesse More  
1st Place: 250.3285 Bu/A  
DKC66-94 Brand

Betsy Belk  
2nd Place: 281.5139 Bu/A  
DKC70-27 Brand

Seth More  
2nd Place: 247.8412 Bu/A  
DKC67-44 Brand

Philip Good  
3rd Place: 231.9467 Bu/A  
DKC67-44 Brand

Garry Nipper  
3rd Place: 255.8224 Bu/A  
DKC68-26RIB Brand Blend

## MISSOURI

Charles Hinkebein  
1st Place: 280.3367 Bu/A  
DKC68-69RIB Brand Blend

David Brand  
2nd Place: 287.5146 Bu/A  
DKC67-44RIB Brand Blend

Joe Mahar  
2nd Place: 290.7814 Bu/A  
DKC64-35RIB Brand Blend

Tory Meyr  
2nd Place: 294.0232 Bu/A  
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Clark Driskell  
3rd Place: 299.6184 Bu/A  
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James Steffens  
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Jeff Baker  
2nd Place: 284.5344 Bu/A  
DKC70-27RIB Brand Blend

Paul Tighe  
2nd Place: 262.0288 Bu/A  
DKC70-27RIB Brand Blend

## NEW JERSEY

Scott Clucas  
2nd Place: 335.0296 Bu/A  
DKC64-34RIB Brand Blend

Eric Eachus  
2nd Place: 287.7902 Bu/A  
DKC64-34RIB Brand Blend

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Jeremy Silsby  
1st Place: 254.6496 Bu/A  
DKC53-56RIB Brand Blend

Henry Everman  
2nd Place: 251.9882 Bu/A  
DKC64-34RIB Brand Blend

Jason Swede  
2nd Place: 259.8390 Bu/A  
DKC52-84RIB Brand Blend

Gary Swede  
3rd Place: 255.3704 Bu/A  
DKC57-75RIB Brand Blend

## NORTH CAROLINA

Isaac Boerema  
1st Place: 262.2850 Bu/A  
DKC67-44 Brand

Delbert Armstrong  
2nd Place: 279.1093 Bu/A  
DKC67-44 Brand

Dennis Boerema  
2nd Place: 305.2941 Bu/A  
DKC70-27 Brand

Stuart Askew  
3rd Place: 226.3860 Bu/A  
DKC67-44 Brand

Charles Grantham  
3rd Place: 290.4626 Bu/A  
DKC65-95 Brand

Ed Wood  
3rd Place: 283.9337 Bu/A  
DKC63-57 Brand

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DKC44-80RIB Brand Blend

Bobby Frauenberg  
1st Place: 290.1933 Bu/A  
DKC44-80RIB Brand Blend

Donna Frauenberg  
1st Place: 283.3963 Bu/A  
DKC45-66RIB Brand Blend

James Frauenberg  
1st Place: 291.7449 Bu/A  
DKC47-27RIB Brand Blend

Betty Huber  
1st Place: 299.7363 Bu/A  
DKC44-80RIB Brand Blend

Steve Huber  
1st Place: 299.8962 Bu/A  
DKC45-66RIB Brand Blend

Cody Frauenberg  
2nd Place: 275.0772 Bu/A  
DKC51-40RIB Brand Blend

Bruce Huber  
2nd Place: 299.6103 Bu/A  
DKC45-66RIB Brand Blend

Sarah Huber  
2nd Place: 297.6772 Bu/A  
DKC44-15RIB Brand Blend

Robert Huber  
3rd Place: 299.0847 Bu/A  
DKC45-66RIB Brand Blend

Riley Jordahl  
3rd Place: 282.3272 Bu/A  
DKC41-99RIB Brand Blend

Nathan Quandt  
3rd Place: 240.7578 Bu/A  
DKC44-80RIB Brand Blend

## OHIO

Cory Atley  
1st Place: 314.5543 Bu/A  
DKC63-57RIB Brand Blend

Luke Swaim  
1st Place: 282.1377 Bu/A  
DKC64-34 Brand

Mike Wolfe  
1st Place: 294.5361 Bu/A  
DKC64-35RIB Brand Blend

Don Jackson  
2nd Place: 290.0481 Bu/A  
DKC64-34RIB Brand Blend

Greg Waters  
2nd Place: 244.9871 Bu/A  
DKC64-34RIB Brand Blend

Alan Borton  
3rd Place: 274.3304 Bu/A  
DKC64-34RIB Brand Blend

Tom Derck  
3rd Place: 210.5527 Bu/A  
DKC55-53RIB Brand Blend

Doug Seaman  
3rd Place: 277.9998 Bu/A  
DKC58-34RIB Brand Blend

## OKLAHOMA

Gayla Ledbetter  
1st Place: 247.8519 Bu/A  
DKC67-44RIB Brand Blend

## OREGON

Miranda Taylor  
3rd Place: 280.2973 Bu/A  
DKC62-08 Brand

## PENNSYLVANIA

Daryl Alger  
1st Place: 319.8425 Bu/A  
DKC62-53RIB Brand Blend

Darren Charles  
1st Place: 335.9360 Bu/A  
DKC62-52RIB Brand Blend

Eric Charles  
1st Place: 323.1911 Bu/A  
DKC62-52RIB Brand Blend

Karl Dirks  
1st Place: 304.7604 Bu/A  
DKC60-88RIB Brand Blend

## SOUTH CAROLINA

Russ Jameson  
1st Place: 306.3421 Bu/A  
DKC70-27 Brand

Michael Young  
1st Place: 305.8587 Bu/A  
DKC62-08 Brand

Daniel Garrick, Sr.  
2nd Place: 294.6200 Bu/A  
DKC65-20 Brand

Jason Hewett  
2nd Place: 257.3633 Bu/A  
DKC70-27 Brand

Daniel Garrick, Jr.  
3rd Place: 289.1287 Bu/A  
DKC65-20 Brand

## SOUTH DAKOTA

Richard Arneson  
2nd Place: 217.4312 Bu/A  
DKC44-80RIB Brand Blend

Kory Standy  
2nd Place: 239.3388 Bu/A  
DKC63-21RIB Brand Blend

Garrett Masat  
3rd Place: 215.8333 Bu/A  
DKC50-09RIB Brand Blend

Adam Wiese  
3rd Place: 219.3366 Bu/A  
DKC58-34RIB Brand Blend

## TENNESSEE

Hunter Hooper  
1st Place: 327.7063 Bu/A  
DKC70-27 Brand

Madison Reed  
1st Place: 328.8126 Bu/A  
DKC67-44 Brand

Brenda Tanner  
1st Place: 295.1404 Bu/A  
DKC68-69 Brand

Kenneth Barnes  
3rd Place: 285.8345 Bu/A  
DKC68-69 Brand

Ethan Tanner  
3rd Place: 296.9665 Bu/A  
DKC70-27 Brand

## TEXAS

Todd Kimbrell, Jr.  
1st Place: 233.2711 Bu/A  
DKC67-99 Brand

## UTAH

Bart Pali  
1st Place: 299.2730 Bu/A  
DKC52-61RIB Brand Blend

Ross Summers  
1st Place: 246.7562 Bu/A  
DKC52-68RIB Brand Blend

Cody Pali  
2nd Place: 295.1556 Bu/A  
DKC52-61RIB Brand Blend

Lynn Summers  
2nd Place: 227.6897 Bu/A  
DKC49-72RIB Brand Blend

Teresa Pali  
3rd Place: 288.0378 Bu/A  
DKC54-38RIB Brand Blend

## VERMONT

Jeffrey Grembowicz  
1st Place: 160.5339 Bu/A  
DKC34-82RIB Brand Blend

Theodore Grembowicz  
1st Place: 155.9524 Bu/A  
DKC34-82RIB Brand Blend

## VIRGINIA

Heath Cutrell  
1st Place: 381.4666 Bu/A  
DKC68-69 Brand

Guy Gochenour  
1st Place: 306.3230 Bu/A  
DKC70-27RIB Brand Blend

Timmy French  
2nd Place: 295.7821 Bu/A  
DKC70-27RIB Brand Blend

Ted Haberland  
2nd Place: 288.6141 Bu/A  
DKC65-95RIB Brand Blend

Theo Haberland  
3rd Place: 271.8982 Bu/A  
DKC67-44RIB Brand Blend

Shane Richman  
3rd Place: 266.7424 Bu/A  
DKC70-27RIB Brand Blend

## WASHINGTON

J. Aeschliman  
1st Place: 119.9172 Bu/A  
DKC27-54 Brand

John Aeschliman  
1st Place: 121.2181 Bu/A  
DKC27-55RIB Brand Blend

Shawn Clausen  
1st Place: 319.0769 Bu/A  
DKC54-38RIB Brand Blend

Scott Gross  
2nd Place: 323.0273 Bu/A  
DKC49-72RIB Brand Blend

Jermey Tuttle  
2nd Place: 315.9320 Bu/A  
DKC62-06 Brand

## WEST VIRGINIA

Justice Family Farms  
1st Place: 273.2937 Bu/A  
DKC65-20 Brand

Chris Miltenberger  
1st Place: 309.8227 Bu/A  
DKC70-27RIB Brand Blend

Margaret Miltenberger  
1st Place: 246.9109 Bu/A  
DKC70-27RIB Brand Blend

Louis Miltenberger  
2nd Place: 259.9291 Bu/A  
DKC67-44RIB Brand Blend

Paul Miltenberger  
2nd Place: 270.2873 Bu/A  
DKC70-27RIB Brand Blend

## WISCONSIN

Tim Appell  
1st Place: 322.2517 Bu/A  
DKC64-34RIB Brand Blend

Lori VanBogaert  
1st Place: 283.5022 Bu/A  
DKC60-88RIB Brand Blend

Mark Bacon  
2nd Place: 268.9666 Bu/A  
DKC52-68RIB Brand Blend

Kyle VanBogaert  
3rd Place: 281.1681 Bu/A  
DKC62-20RIB Brand Blend

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# Trio of New Threats

*Keep your eyes peeled for these troublemakers.*

**Just when you thought you'd battled every crop pest under the sun,** an all-new problem pops up. How problematic the threat becomes is sometimes a question, but early awareness is key.

Here are three new invaders scientists are currently working hard to figure out:

## SOYBEAN GALL MIDGE

Wayne Martin may not plant many soybeans this year.

The Shelby, Iowa, farmer isn't sure he can stomach another round with soybean gall midge, a pest that showed up in his fields in 2018.

The maggotlike critter eats away inside soybean stems until the plant dies. It's now in parts of Iowa, Minnesota, Missouri, Nebraska and South Dakota.

Giant leaps have been made in understanding gall midge habits, says Justin McMechan, a University of Nebraska entomologist. "The challenge is there is still no practical way to manage the pest without limiting the yield potential of the crop," he notes.

Scientists have identified the adult—an entirely new species of midge. In 2019, McMechan found adult flies emerging and laying eggs continuously in June and July—the long emergence period means that insecticides can't be the only means of control. And, the orange larvae overwinter in the soil.

Early-planted soybeans sometimes suffer more because adults prefer laying eggs in the cracks that open naturally in the soybean stem around V3. McMechan says alfalfa and sweet clover were identified as alternative hosts, but soybean fields planted near soybeans that were infested last year are likely most at risk.

"We are sharing information as we fast as we get it, but farmers need to understand that many of our findings aren't replicated and to expect changes in what we know," McMechan says.



## COTTON LEAFROLL DWARF VIRUS

Those strange-looking cotton plants that whip above the late-season plant canopy may actually be infected with cotton leafroll dwarf virus (CLRVD).

Transmitted by aphids, the virus causes cotton leafroll dwarf disease (CLRDD) in cotton.

CLRVD is difficult to diagnose, as symptoms vary and can mimic other production issues. Compact internodes in the terminal, leaf discoloration, tissue reddening, leaf rugosity (puckering), reduced boll set and late-season vegetative growth are common clues.

However, Tom Allen, Mississippi State University plant pathologist, says plants that appear to be symptomatic don't always test positive for the virus, and infected plants don't always have symptoms.

Documented in Alabama in 2017, the virus and disease have now been confirmed in numerous states across the Cotton Belt.

"We're working hard to unlock its secrets and advising growers not to panic," Allen says. "So far, CLRVD isn't presenting huge yield losses, but we want to keep it that way."



*Random oversized cotton plants that whip above the canopy are one symptom plants may be infected with CLRVD.*

## SPOTTED LANTERNFLY

The spotted lanternfly's bold coloring and spotted wings combine with a large body to make it a visible invader. Still, its proclivity to lay eggs on nearly any flat surface like car bumpers and railroad cars also turns it into a moving threat.

While currently causing havoc in the mid-Atlantic states, University of Missouri entomologist Kevin Rice urges Midwest farmers to watch for the pest. "Most insects are really good moms and like to put their eggs where they can survive by eating that host," Rice says. "This pest is an indiscriminate egg layer, and the transportation element threatens a potentially explosive spread."

The lanternfly is partial to the tree of heaven (*Ailanthus altissima*) but feeds on 70 different U.S. crops and plants. Last year, USDA made \$17.5 million in emergency funding available to stop the pest's spread in Pennsylvania, where it has caused damage to stone fruits, grapes and residential properties.

If you find one of these bawdy invaders, contact your local Extension office or department of agriculture. ///





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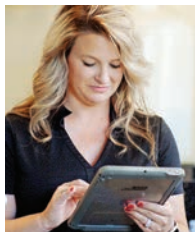
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# Ask the Agronomist



Dr. Cristie Preston

## Phosphorus on Corn for 2020 Success

Optimizing returns on every dollar spent on fertilizer and crop nutrition holds the key to profitable crop production. Ask the Agronomist, brought to you by eKonomics, provides crucial nutrient management answers as you prepare for the 2020 growing season.

### **Q At what corn growth stage is phosphorus needed most, and how critical is soil pH for phosphorus uptake?**

*Dr. Cristie Preston:* When I talk to farmers about phosphorus, my first question is, “What’s your soil pH?” Phosphorus plant availability can be significantly affected by the soil pH. Areas where the soil pH is below 5.5, phosphorus availability is controlled by iron and aluminum. Above 7.5, phosphorus is controlled by calcium. Greatest phosphorus availability is between 6.5 and 7.5. If your pH is outside the optimum range, your soil test level may not accurately reflect phosphorus availability to the plant. A high or low pH can potentially affect the phosphorus that you apply. So, it’s difficult to predict if you would see a response.

Phosphorus uptake really begins to increase as the crop moves from the V6 to V8 growth stages.

### **Q Focusing on phosphorus in starter fertilizer, what conditions offer the most significant crop response?**

*Preston:* First, response to fertilizer phosphorus, especially starter, might be even greater at non optimal pH because of reduced availability of soil phosphorus. Second, when the phosphorus soil test level is below critical, you’ll see the highest corn crop response. Even when test levels are above critical, there can still be a positive response to phosphorus in starter fertilizer. Third, if you plant in any conditions that may restrict early root growth such as soils that are compacted or too wet/dry, cool spring conditions, you want phosphorus closest to the plant for the best root growth benefit, such as in a 2x2 or 2x2x2 band, since these conditions reduce uptake.

### **Q Can phosphorus help fields that suffered Prevent Plant in 2019?**

*Preston:* Farmers who suffered through Prevent Plant acres in 2019 can benefit from phosphorus in starter fertilizer. If there were no living roots in a field in 2019, phosphorus can help achieve quicker root establishment to improve mycorrhizal relationships with corn root growth to improve uptake. It is similar to the scenario when corn follows sugar beets or canola; there is a greater chance of phosphorus deficiency.

### **Q Using the eKonomics ROI calculator tool, how can a farmer maximize yield with phosphorus applications?**

*Preston:* The ROI tool allows farmers to input site-specific farm data on phosphorus and potassium to make fertilizer

decisions. Fertilizer recommendations are based on years of university research trials. Results take into account spatial variability. If the soil test level is right at or below the critical level, since it is an average, there will be areas within the 2.5 acres that could be yield-limiting due to low phosphorus levels. When soil test levels drop below critical, yields and returns are potentially limited.

### **Q The Nutrient Removal calculator helps farmers grasp pounds and dollars removed by grain yield. How do growers compare the Build-Maintain and Sufficiency approach?**

*Preston:* It is critical to calculate what nutrients have been removed. The Sufficiency approach takes into account the economic optimum fertilizer rate for that year. If soil test levels are above the critical level, the recommendation would be zero pounds of fertilizer.

The Build-Maintain approach ensures soil test levels are built up above critical levels, and removal rates are applied. Since soil sampling methods are an average of an area, there are locations within that area that are above and below the reported value. If the soil test levels are close to the critical level, yields may decrease due to a lack of optimum phosphorus or potassium levels. The Build-Maintain approach increases soil test levels above the critical and maintains them to ensure maximum yield. This method is more costly, however it means a farmer can hedge his bets on not having yield-limiting conditions in the field.

The Build-Maintain strategy may be preferred if the farmer owns the land or has a long-term lease since it’s based on banking some phosphorus and potassium in the soil for future years. In contrast, the Sufficiency level strategy may be more suitable for short-term land tenure or in cases of limited available capital, as it’s based on applying just what is needed for the current crop.

## For More Information

Visit [Nutrien-eKonomics.com](https://www.nutrien-ekonomics.com) for news and fertility management information. It also contains valuable tools like a rainfall tracker and Growing Degree Day calculator to help farmers assess possible fertility loss and plant development needs.

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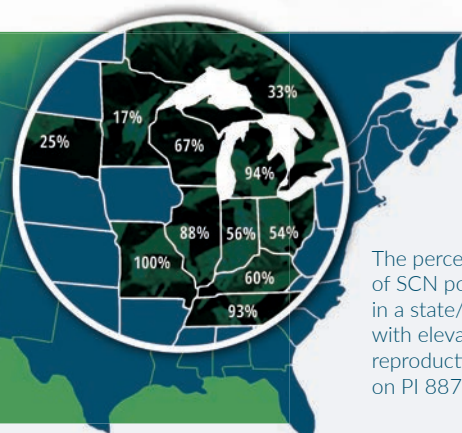
# SCN REPRODUCTION PUTS RABBITS

## WHY YOU NEED to test your fields for SCN.

For more than 20 years, greater than 95 percent of all SCN-resistant soybean varieties have included resistance from the PI 88788 breeding line.

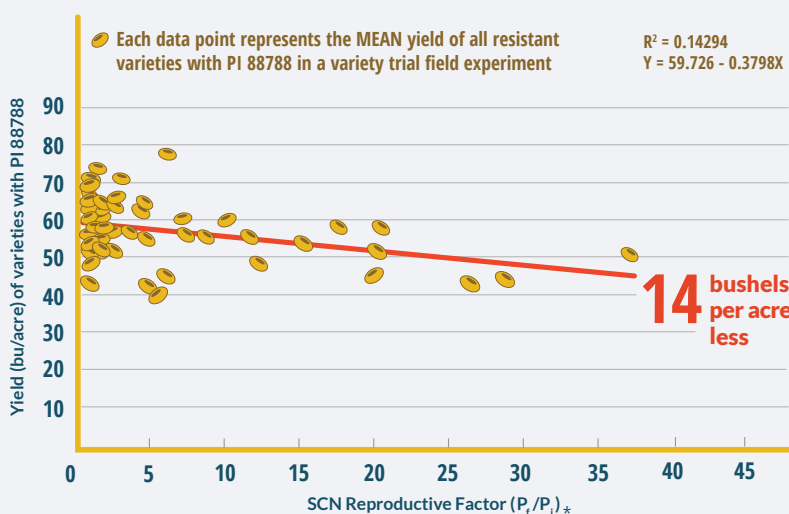
### Nematodes are becoming “resistant to the resistance.”

A resistant variety should allow less than 10 percent reproduction. In other words, a resistant variety should stop 90 percent of the SCN in a field from reproducing. Across the region, varieties with PI 88788 resistance aren't hitting the mark. On some farms, one out of every two nematodes can reproduce.



The percentage of SCN populations in a state/province with elevated reproduction (>10%) on PI 88788

## AS SCN REPRODUCTION INCREASES, yields decrease by as much as 14 bushels per acre.



Research shows yield loss as SCN populations increase on varieties with the PI 88788 resistance source. This data is from 25 years of variety trial experiments in farmers' fields in Iowa.

**The Reproductive Factor (RF)** is the end-of-season number of SCN eggs divided by the beginning-season number of eggs. An RF of 2 means SCN egg numbers doubled from spring to fall. An RF of 4 means egg numbers quadrupled. The last data point on the far right in the graph has an RF of almost 40 (a fortyfold increase).

\*McCarville, M.C. et al. 2017.  
PHP dx.doi.org/10.1094/PHP-RS-16-0062.

# TO SHAME

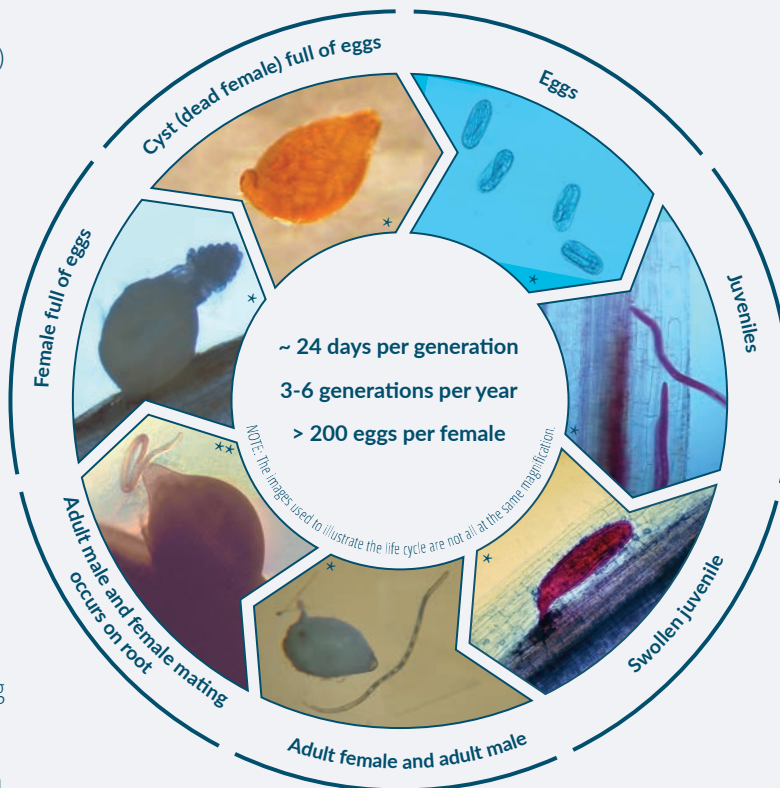
## THE SOYBEAN CYST NEMATODE life cycle.

The SCN life cycle can be completed in as few as 24 days during the growing season. There can be from three to six generations per year. Even with an attrition rate of 99 percent (meaning only 1 percent of eggs survive each generation), 200 eggs from one cyst can become 48,828 eggs after four generations.

**EACH CYST** (dead female) contains 200 or more eggs.

**AFTER MATING**, she makes about 50 eggs outside her body and fills up with another 200+ internally. Then she dies and her body wall hardens to form the cyst.

**THE FEMALE GETS SO LARGE** that she ruptures out of the root onto the root surface and sends out a chemical signal to attract mates. There's no such thing as nematode monogamy. Females mate with many males, and males mate with many females. There's a lot of genetic mixing.



**WHEN THE CYST BREAKS**, half of the eggs will become male and half will become female.

**JUVENILE WORMS** hatch from eggs and burrow into soybean roots to feed and develop. There's no way to tell whether a juvenile is male or female at this stage.

**THIS JUVENILE IS SWOLLEN** from feeding in the root for several days. If this juvenile is female, she'll stay in the soybean root and keep feeding.

**IF THE JUVENILE IS MALE**, it will revert back to a worm shape and leave the root.

\* Tylka, Iowa State University  
\*\* Chitwood, USDA

Visit [TheSCNcoalition.com](http://TheSCNcoalition.com) for more information.





RON HECK

## SCN Sleuth

*Meet the Iowa farmer who refused to be beat by an unseen pest.*

### UNRAVELING A MYSTERY

Heck suspected great yield variability in his soybean fields prior to the mid-1990s, but he didn't know for sure. It wasn't until he installed a yield monitor in his combine 26 years ago and embraced precision agriculture, including yield mapping, that it was confirmed.

In those days, yields fluctuated from 20 to 60 bushels per acre (bpa) within many fields, even those with few visual symptoms. Why? Initial guesses were iron deficiency chlorosis or problems with pH, fertilizer or drainage.

"I didn't know anything

about SCN. It was a Southern problem, so we thought," Heck says.

He showed the maps to Iowa State University (ISU) researchers and fellow Iowa Soybean Promotion Board (ISPB) and ISA directors.

Heck surmised if his fields succumbed to mysterious yield variations, it wasn't an isolated case. He suggested to colleagues to use soybean checkoff money to fund an on-farm research project to find out why.

"It was not a hard sell," recalls Lorimor, then chairman of the ISPB Research Committee. "If Ron hadn't (suggested the project), we might not have ever got started."

### ON-FARM RESEARCH

The study, which started in 1996, consisted of two 50-acre sections of the middle of two fields in a corn/soybean rotation on Heck's farm. Each section was divided into half-acre grids. Two other sites were added in years two and three.

Researchers studied everything that could cause soybean yield variations—compaction, weed control, seed population, soil type, etc.

"Soil tests were taken along with an SCN count not expecting to find anything," Heck remembers. "We were all surprised that not only did I have nematodes but a lot of them. Some counts exceeded 30,000 (eggs per 100 cc [cubic centimeter] of soil)."

"I thought a 45-bpa average was good, but I could have had 55 or better with the right soybean varieties and had I known what to do," Heck says.

**Ron Heck isn't known to wear an ascot, but** maybe he should after helping solve one of the Midwest's great agricultural mysteries.

The Perry, Iowa, farmer has a lot in common with Freddy of "Scooby-Doo, Where Are You?" fame. Both have the drive to decipher whodunits—but in different ways.

The teenage sleuth would devise a kooky trap to catch the fake ghost to solve a crime. Heck simply used an inquisitive nature, a little persuasion and, most importantly, yield maps in 1994 to eventually "unmask" once-mysterious villains, soybean cyst nematodes (SCNs). It was and continues to be the No. 1 soybean yield robber responsible for an estimated \$1 billion in losses annually, experts say.

But, it used to be much worse. Industry officials and farmers agree Heck played a pivotal role in increasing awareness of SCN and its devastating effects in the Midwest. That led to more intensive management of the pest, Heck's prominent role fighting SCN, significant yield increases that put billions of dollars in growers' pockets and a shift in agricultural research.

"Ron is a visionary and insightful enough to recognize how this new tool in the early 1990s (yield mapping) could so powerfully be used," says Kirk Leeds, Iowa Soybean Association (ISA) CEO. "He made a difference ... and set the stage for what was to come."

Farragut, Iowa, farmer Steve Lorimor adds, "Ron's the guy with an answer to a question that nobody else could answer."

## HECK'S ROTATION FOR SCN SUCCESS

Managing SCN is a lengthy process. It took Ron Heck years to reduce and keep SCN populations low. Yields jumped 10 bpa or more as a result.

Here's Heck's six-year strategy to reduce SCN yield loss and egg count:

- **Season 1:** Plant a PI 88788-resistant soybean variety.
- **Season 2:** Plant corn.
- **Season 3:** Plant a different PI 88788-resistant soybean variety.
- **Season 4:** Plant corn.
- **Season 5:** Plant a Peking resistant soybean variety.
- **Season 6:** Plant corn.

### CATALYST FOR CHANGE

The study's data proving SCN is the primary soybean-yield-stealing culprit has changed the industry, officials contend.

The North Central Soybean Research Program started the SCN Coalition in 1997. The group's iconic campaign, "Take the Test, Beat the Pest,"

pushed awareness and soil testing for SCN. University researchers worked together more than ever to offer management recommendations.

SCN-resistant soybean varieties weren't available in large quantities or bred with northern soil and climates in mind. Soybean associations, with tens of thousands of members each, convinced seed companies and public breeders to change that.

Yield losses attributed to the parasite were reduced 5 to 10 bpa or more, depending on the severity, Heck says. But, they weren't eliminated.

SCN is no longer a mysterious yield robber thanks to Heck's actions. Though still a problem, it's not as costly as it once was.

"You get a big smile out of me for that," Heck says. "We changed the industry for the better. We made soybeans a better crop." ///

► Follow Matthew Wilde on Twitter @progressivwilde.

### FOR MORE INFORMATION

SCN Coalition: [www.thescncoalition.com](http://www.thescncoalition.com)



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# A New Movement

*The push for SCN varietal resistance broadens.*

**If you owned one pair of blue jeans and wore them every day for two decades, you'd expect some wear and tear.**

In much the same way, the genetic resistance you depend on to protect against soybean cyst nematode (SCN) is fraying. Some 95% of the commercially available SCN-resistant varieties depend on a single source of resistance called PI 88788.

"In the last decade, we've seen a reduction in the effectiveness of PI 88788 in the prime soybean-growing areas," says Kaitlyn Bissonnette, a University of Missouri plant pathologist. "Soybean farmers need to be clamoring for increased access to new sources of varietal resistance."



UNIVERSITY OF ILLINOIS

*Some SCN-resistant genes are easier to work with than others when it comes to inserting into high-yielding lines, but plant breeders are making breakthroughs, says Brian Diers, University of Illinois.*

## THE CHALLENGE

Soybean breeders have been working for years to insert other types of genetic resistance into elite soybean varieties. PI 548402 (Peking), PI 90763 and PI 437654 (Hartwig) are the most promising, but they are much more difficult to work with than the PI 88788 variety.

Brian Diers, a University of Illinois plant breeder, explains that PI 88788 involves one major gene: Rhg1. Peking, on the other hand, involves two genes: Rhg1 and Rhg4. It's simply harder for breeders to work with two genes, and it takes time to achieve yield parity.

"But, as you continue cycles of breeding, you are able to incorporate these genes more readily into elite, high-yielding lines," Diers says. Better genetic markers also help breeders select the genes needed and speed varietal development.

## VARIETY ACCESS GROWS

Soybean growers, particularly in the Midwest, are seeing more soybean varieties enter the market with the Peking source of resistance, offering farmers more opportunities to rotate sources of varietal

resistance. "We have a large amount of evidence showing that this reduces selection pressure on SCN populations to continually adapt," Diers says.

More cultivars with PI 437654 (Hartwig) are coming, too. Diers says his Illinois program released two high-yielding lines, which were commercialized by companies through licenses from the university.

Diers' team also recently released a variety with a three-gene stack. "We combined the two resistance genes from wild soybean with Rhg1 from PI 88788 and have shown that this combination gives greater resistance than Rhg1 alone," he says.

He's also developed a four-gene stack—two new resistance genes from wild soybean stacked with Rhg1 from PI 88788, plus another resistance gene from PI 567516C. "If you look in the literature, there are many SCN-resistance genes that have been mapped," he says. "We worked on the gene from PI 567516C because it can give a greater increase in resistance than most other genes identified."

## ANOTHER TYPE OF ROTATION

Farmers battling aggressive nematode populations should note that not all varieties containing PI 88788 are created equal. Simply rotating between soybean varieties may be helpful, Diers notes.

"Varieties derived from PI 88788 resistance do not all have the same level of resistance, and this may be related to the number of copies of the Rhg1 gene. There are normally 10 copies of the Rhg1 gene in varieties with PI 88788 resistance, but some may have fewer copies. With PI 88788, the higher the copy number, the higher the resistance," he explains. ///



PAMELA SMITH

*Varieties containing Peking as a source of SCN resistance are increasingly available through commercial companies.*

## FOR MORE INFORMATION

The SCN Coalition: [www.thescncoalition.com](http://www.thescncoalition.com)



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# PHIL FRIEDRICH

## Illinois Farmer's Approach to Winning Yield in Every Field

**P**hil Friedrich, corn farmer and Stoller customer, **won the 2019 NCGA yield contest in the Illinois conventional irrigated division.** Friedrich brought in just over 314 bushels per acre, despite a difficult year with weather. He has been entering yield contests since the early 1980's and has achieved several contest wins as a result of his hard work and innovation. Friedrich credits the contests for helping to educate farmers on different growing ideas.

Over the past few decades of Friedrich's innovative farming, he has trusted Stoller products and experts to help him achieve yield-winning results. What Friedrich appreciates about Stoller products is that he can incorporate them into the passes he is already making while planting, spraying, and irrigating.

Friedrich starts by incorporating Stimulate® Yield Enhancer Plus in-furrow with his starter fertilizer, as well as a combination of Stoller products when making his post-emergent

pass. During the growing season, he applies Harvest More™ Urea Mate through the irrigation system. He uses Bio-Forge® Advanced to deal with weather-related stress.

"We like the Harvest More™ Urea Mate because it gives us a balanced approach to micro and macro nutrients. It's a product that provides quite a range of different nutrients in a form that is readily available and fairly easy to maintain in suspension and run through the irrigator," said Friedrich.

Then, Friedrich finishes strong by using Sugar Mover® with his fungicide pass to supply necessary nutrients to increase yield at the end of the season.

If you would like to learn how to achieve greater yield in your field and become a yield champion like Phil Friedrich, contact a Stoller representative.

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PAMELA SMITH

# Soldiers of the Soil

*Beneath the surface, organisms are toiling to help your crop.*

**Most soil ecosystems are a friendlier place than we realize.**

“I think it’s safe to say that—just like with the human microbiome—most of the microbes in the soil are not pathogenic,” says M. Soledad Benitez Ponce, who studies phytobacteriology at Ohio State University. “Especially in more natural ecosystems, pathogens are usually a minority.”

From plant-loving mycorrhizae to nitrogen-fixing bacteria, your crop’s roots are living in a diverse subsoil world of helpful microbes. Here’s a look at some of what’s working.

## FUNGAL FAVORITES

Mycorrhizae are a diverse group of soil-dwelling fungi that form a “symbiotic” relationship with many plants, meaning they have a “mutualistic” or mutually beneficial relationship.

“This is a very old relationship between this group of fungi and plants,” Benitez Ponce explains. “One of the hypotheses out there is that plants were able to initially establish on land because of their association with this type of fungi.”

The best-known type of these fungi for agricultural crops is called arbuscular mycorrhizal fungi. Just like a fungal pathogen, these fungi infect and colonize a crop’s plant tissue. Once inside, they form tiny, multibranched structures called arbuscules.

Here, the fungi can take in the carbon nutrients they need to survive. In return, they help the plant uptake key nutrients from the soil, she says.

“They are most famous for helping with phosphorus uptake. But, there are other ways they can benefit plant growth—some research has shown that they help prime a plant’s immunity. The plant has a better response to stresses like pathogens and drought,” Benitez Ponce says.

These soil fungi also form long, white threads called hyphae. These threads, as thin as a hair, wind their way through their earthen surroundings to create delicate, soil-hugging webs.

“They can actually help with soil health by creating good soil structure—these hyphae help keep the soil together and help with soil aggregation,” Benitez Ponce explains.

Another group of beneficial fungi is called Trichoderma. Research shows that some strains of these fungi can help with photosynthesis, improve nutrient uptake and even help fight soil-dwelling pathogens like Fusarium.

“There is a very specific activity in some species of Trichoderma that can kill other fungal pathogens—they are mycoparasites of those fungal pathogens,” Benitez Ponce says.

## BACTERIAL BLESSINGS

Rhizobia bacteria are probably the most famous of their kin for their legume-loving ways, Benitez Ponce

notes. Like beneficial fungi, these bacteria engage in a courtship-like ritual with the roots of a potential host plant—sniffing out a chemical signal from the plant, sending out their own signal and awaiting the plant’s response before latching onto its roots.

Once accepted by the plant, rhizobia bacteria form large, round nodules on the roots of the legume that are visible to the human eye. Each nodule, teeming with bacteria, fixes nitrogen gas from its surroundings and makes it available to the plant.

This process is so beneficial for legumes such as soybeans that many companies offer soybean inoculants that introduce rhizobia into a field to encourage nitrogen fixation.

Other bacteria helpers belong to the genus *Pseudomonas*. While some species within this genus are harmful pathogens, many others have valuable biocontrol abilities to protect crops from pathogens, Benitez Ponce says. Some even produce their own type of antibiotics that target other bacteria in the soil.

Another group of bacteria, Actinobacteria, are also valuable disease-fighters (though some can also be pathogenic). One type, *Streptomyces*, are known to be prolific antibiotic producers. This group of bacteria can

produce a range of other biocontrol agents, as well, such as antifungals, antivirals, herbicides, fungicides and growth-promoting substances.

In general, these bacteria hang out in the soil near the root zone of plants and are free-floating organisms, Benitez Ponce explains. Because of their beneficial properties, many companies have commercialized species from these bacterial groups and sell them as biological products to farmers.

### HOSPITABLE SOILS

How can farmers encourage these plant-loving microbes?

Because soil ecosystems are so complex, there is no simple answer, Benitez Ponce says. But, a good start is increasing the diversity of your cropping system, which can supply microbes with a greater variety of food.

Given that tillage can destroy the soil-aggregating hyphae structures, no-till systems are likely better for fungal species like mycorrhizae, as well as overall soil health, she adds.

Finally, overfertilization can also mute the activity of nutrient-uptaking fungi like mycorrhizae, she cautions.

“That symbiotic system sort of shuts off in heavily fertilized situations,” Benitez Ponce explains. ///

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# Returning home to help shape the future of the family farm

After earning her degree and working in the ag industry, **Erin Holbert** returned home to help run the family farm. This young producer is striving to honor her dad's proven techniques and trusted solutions while making her own mark on the family business.

"For as long as I can remember, my dad said 'you have to work off of the farm for a minimum of two years just to really appreciate what you have coming back,'" explained Erin Holbert. "I hate to say it, but he was right."

The young Indiana producer did just that. After earning a degree in agriculture business and management with a minor in crop science from Purdue University, Holbert spent three years working in the industry. First, as a farm intern and a sales agronomist at Cargill, and then as an account manager for a regional seed dealer.

"Now, I can appreciate being on the farm — even on bad days and during tough times," Holbert said. "For example, 2019 was hard from the start. We were consistently a solid three to four weeks behind all season, but I'm happy to be here and proud to be a farmer."

## Getting hands-on

Together with her dad and a full-time employee, Holbert raises corn and soybeans near the town of Dana, located a few miles from the Indiana/Illinois border. While she grew

up helping out on the farm, she's now learning the skills she needs to take it over. During this transitional phase, Holbert is careful to maintain the successful program her dad has in place while working to put her own mark on the family business.

Holbert is completely hands-on. Depending on the season, she can be found planting beans, walking crops, working the grain cart, or doing paperwork in preparation for taxes.

## Using trusted tools

To help manage day-to-day challenges — especially around the weather — father and daughter rely on DTN solutions. The company's satellite solution was a constant presence during Holbert's childhood on the farm.

While her dad still enjoys his trusted satellite service, they now also rely on the mobile-friendly MyDTN, DTN Ag Weather Station, and the DTN Ag Weather Tools app. They both like being able to monitor the markets, news, and weather while working in their fields.

"Our DTN weather station provides us with the most accurate information. It makes a real difference when it comes to decisions around planting, spraying, and more."

Erin Holbert





Follow Holbert on Twitter and Instagram: [@ernholbert](#)

"I'm lucky that my dad is tech-savvy," she explained. "He's 100% on board with trying new things and using apps."

Holbert's day typically starts by checking her email for news and alerts from DTN. "It will tell me if corn is lower or higher, and if I can expect rain today," she said. "By checking the weather and the markets, I know what I'm going to be dealing with at work."

### Managing the weather

Holbert and her dad agree that the weather from DTN is the most accurate, which is something he has told her for years. She explained that she has five different weather apps on her phone that she checks more often than Twitter, but the DTN app is the only one she trusts. "The rest are just guesses," she said.

To get the highest level of accuracy, the Holberts added a DTN Ag Weather Station to the farm. It gathers detailed weather and agronomy data right from their fields, which helps them make a wide variety of operational decisions with greater confidence.

"It's especially important to us when it comes to spraying beans," she explained. "We take the responsibility very seriously. Our DTN solutions help us to prevent drift, which is something no farmer wants to experience."

### Making her mark

Holbert plans to use her education and business experience to benefit the farm. She's also active on social media and has a large Twitter following, which enables her to network and exchange ideas with other producers from across the country.

To help shape future ag solutions, Holbert recently became a DTN brand ambassador. In the role, she tries out new technology and provides critical feedback that helps ensure the products deliver the greatest value to producers.

### Learn more

To more about the DTN solutions Holbert uses in the family operation, please visit [www.dtn.com/mid-feb-pf](http://www.dtn.com/mid-feb-pf) or call 1-888-350-0972. ■





# Customize Vaccines

*When a standard treatment isn't doing the job, it may be time to take a more targeted approach.*

**O**ne size doesn't always fit all when it comes to vaccines in a cattle herd. That's one reason it's becoming more common to hear of cases where a custom vaccine, also known as an autogenous vaccine, is the answer to some ongoing health issues in a herd.

This is not a first-stop kind of solution. There's a process. It starts with a visit with your herd veterinarian, where you explain you're not getting the control you think you should when it comes to something like pink eye or scours. After doing some diagnostics, your veterinarian may agree it's time to consider an autogenous vaccine.

Veterinarian Ken McMillan, longtime writer of *Progressive Farmer's* "Ask the Vet" column, says he's used autogenous vaccines in his Cropwell, Alabama, practice to treat both warts and infectious bovine keratoconjunctivitis (pink eye).

He explains, "The most common cause of pink eye in cattle is *Moraxella bovis*, but we are seeing more infections now caused by *Moraxella bovoculi*. Most commercial pink eye products, however, only contain *Moraxella bovis*, and even then do not always protect against the specific strains causing the disease."

There is one commercially available product that contains *Moraxella bovoculi* but none that combine it with the more common *Moraxella bovis*.

McMillan adds his experience in the field has been that custom vaccines can be very effective when compared to commercial alternatives.

## THINK PREVENTION

Randy Shirbroun agrees more cattle producers are seeking herd-specific products today.

A veterinarian with Newport Laboratories technical services, Shirbroun says in addition to pink eye, scours are a common reason for the use of autogenous vaccines. Being able to pinpoint the pathogen behind a hard-to-control health issue like this can be key to turning it around.

He stresses autogenous vaccines are not like buying a product off the shelf. They result from a process that begins with diagnostics, where the lab works with a veterinarian to test the strain, or variation, of a pathogen causing a health issue in a herd. Typically, this pathogen will be bacterial.

Shirbroun notes it can take six to 10 weeks to identify this pathogen and produce the autogenous vaccine. This includes quality control and USDA testing. USDA-licensed laboratories produce these vaccines.

Because of the time it takes to go through the process, Shirbroun says the idea is to make enough of the vaccine not just for the individual(s) with the issue today but for the whole herd next season.

"This is with the expectation that in all likelihood, the same pathogen is going to be in the same environment next calving season," he says of something like scours. "So, we want to vaccinate the cows prior to calving with this autogenous vaccine. This way, we can prevent the same issue in the next calf crop."

While producers often try to control issues like this by moving cattle into a new environment, Shirbroun says this approach generally has limited success.

"It may help to move to new pastures, but it won't eliminate these pathogens. They are in the cow's lower intestine,



CLAIRE WATH

*It can take six to 10 weeks to identify a pathogen and create a custom vaccine.*

*Moving the herd to new pasture won't eliminate pathogens carried in the lower intestine.*

as well as in the environment,” he explains. “So, yes, changing pastures is a smart management decision. But, you may still want to use an autogenous vaccine next season, especially if you’re dealing with an unusual pathogen.”

### COMPARABLE COSTS

Anything custom-made is usually more costly, but Shirbroun says that isn’t necessarily the case with autogenous vaccines. While it varies with the vaccine, these products are priced to the vet and are typically comparable to off-the-shelf standard vaccines.

Alabama’s McMillan adds he’d like people to know that autogenous vaccines aren’t just for cattle. In fact, they are regularly used in other species.

“The use of autogenous vaccines is common in swine and poultry. They are also frequently used in sheep and



VICTORIA G. MYERS

goats, because there are so few commercial products produced for them,” he says. “The takeaway is that veterinarians today can go beyond that off-the-shelf vaccine and find ways to help farmers and ranchers control ongoing issues that are costing them money in loss or treatment. Communication is really the key.” ///

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ERIC CHRISTENSEN

## Pick Up On Earlage

*Sustainability and practicality have more beef producers considering this feeding alternative.*

**S**ometimes, the old ways are the best. That's how Eric Christensen feels about earlage in cattle rations. He's following his grandfather's practice of using the ensiled corn product here on the family's eastern-Colorado operation, Christensen Ranch.

Established by Edward R. Christensen in 1923, this ranch started incorporating earlage into its feeding program during the 1940s. It allowed for early harvest and offered the option of using just the grain and cobs, or adding corn stalks and husks to a ration. It tended to be higher in energy (starch) than corn silage, a plus during the cold winters here.

Eric and his ranch partner cousin, Kathy Wood, say what worked then is still a good practice now. It's an especially important element in the sustainability of their beef operation.

"As members of Global Animal Partnership, we focus on animal welfare from pasture to plate, raising cattle

without hormone implants or antibiotics," Christensen says. "We pasture-raise cattle until they're ready to finish then put them on a ration that includes earlage. We want to put fat in the marbling of our cattle where it improves meat quality and flavor."

The farm's first earlage tool was a hammer mill. This is a mill with the purpose of shredding or crushing material through grinding or repeated blows from little hammers mounted in a steel drum. Christensen's father picked corn he wanted to use as earlage by hand, stored it in a bin then crushed it in the hammer mill rather than shelling it. Today, Christensen uses a kernel processor on a forage harvester, equipped with shearing action to crack close to 100% of kernels and chop cobs and husks at the same time.

"We harvest at about 36 to 38% moisture," Christensen says. "It keeps better in the bunker at that moisture level."

Eralge is covered with plastic as soon as possible after harvest. He says with quick-drying genetics, the biggest challenge they face is harvesting the corn once it's mature but before it dries down too much. They use a variety of corn that can be harvested either as earlage or silage, giving them an option in this area where hail can be common.

### PUTTING ON A FINISH

"When we bring cattle into the feedyard to finish, we start with a small percentage of earlage in the ration

and slowly increase that over a four-week period,” Christensen says.

“Earlage is very palatable, and it tends to help new feeder cattle quickly get their head in the bunk. At the end of their finishing period, the ration is between 80 and 85% earlage.”

Since getting hay up while it’s dry is also very challenging here, Christensen says he typically harvests haylage to use in the feed ration. He’ll add some dry hay, as needed. Cattle aren’t pushed to finish within a specific time frame. He believes allowing them to fatten at an average daily gain of 3 pounds results in a higher grade at the packer.

Greg Lardy, longtime head of North Dakota State University’s department of animal sciences, notes earlage is generally higher in energy than corn silage, with similar protein content. But, it has lower energy than dry or high-moisture corn grain.

“Earlage works well in a variety of cattle diets, including growing and finishing diets for beef cattle and feed for lactating dairy cows,” he says. “It may also be referred to as snaplage, high-moisture ear corn, or corn and cob meal.”



*Haylage is mixed with earlage in a ration that yields average daily gains of 3 pounds and results in higher grades.*

### EARLAGE PROS AND CONS

Advantages of earlage check a lot of boxes, from economic to ease of use to feeding efficiency.

To begin, Lardy notes the obvious: The practice eliminates drying costs. It can also increase dry-matter yield by 20% compared with conventional corn harvest. >

**“Weeds rob me of my investment — taking up nitrogen and water and crowding out grass.”**

**DR. NANCY JACKSON, DVM**  
SOUTHERN CROSS FARM, MISSISSIPPI





## Compare Corn Feed Types

CORN TYPE	DM	TDN %	NE <sub>m</sub> Mcal/lb	NE <sub>g</sub> Mcal/lb	CP %
<b>GRAIN</b>					
Dry-rolled	86	90	1.02	0.70	9.8
Ear	87	83	0.92	0.62	9.0
High-moisture	75	90	1.02	0.70	10.0
<b>EARLAGE</b>					
High-moisture ear corn, harvested with a snapper head	75	83	0.92	0.62	8.7
Earlage, well-eared, harvested with all-crop head	60-70	78	0.86	0.57	8.8
Earlage, less grain, harvested with all-crop head	60-70	74	0.80	0.52	8.8
<b>SILAGE</b>					
Well-eared	35	70	0.74	0.47	8.0
Drought-stressed	35	65	0.67	0.40	11.1

DM—Dry Matter; TDN—Total Digestible Nutrients; NE<sub>m</sub>—Net Energy/Maintenance; NE<sub>g</sub>—Net Energy/Gain; CP—Crude Protein  
SOURCE: NORTH DAKOTA STATE UNIVERSITY

On the management side, earlage lengthens harvest windows, giving producers the option of using longer-season corn varieties. These can potentially produce 3 to 5 bushels per acre for every day of relative maturity.

When it comes to feeding, Lardy agrees with Christensen that earlage is highly palatable and mixes well with other forages and feeds. Cattle tend to feed more consistently when earlage is an option, partly because of the digestible fiber in the cob and husk. And, don't overlook the positive effect of the cobs' "scratch factor" in the rumen.

Harvest residue from earlage can often even extend fall grazing windows. The residue is lower in volume and nutritional quality, however, a fact that should be

*Earlage mixes well with other forages and feeds, and harvest residue can be a way to extend the grazing season for some.*



accounted for. Once cattle are off the fields, residue from the crop reduces potential for erosion. If there is a downside to earlage, it would be a limited market. This is only used as a feed for ruminants. No other markets are available.

When earlage is harvested late, cobs are low in digestibility. This reduces energy content in the ration relative to dry grain. And, earlage is typically lower in protein than other corn grain products.

Proper ensiling is critical, because without it, earlage losses from spoilage and shrink can be excessive.

"Earlage ensiling is basically the same as silage," Lardy explains. "You need to exclude oxygen and pack it just as you would silage. It must be covered as soon as possible with plastic to prevent oxygen penetration, and the plastic must be tightly sealed and secured to maintain the seal."

Inoculants may be a valuable addition to earlage during harvest and ensiling. Custom-chopping operations often have the equipment necessary for producing good-quality earlage. In addition to a kernel processor, an all-crop header can be used to take the upper third of the corn stalk along with all the ears. This method produces more overall tonnage, but the energy and protein content of the feed will usually be lower.

### FLAVOR BOOSTS

Christensen Ranch produces beef for Meyer Natural Angus Beef, a company focused on its commitment to offer customers what it describes as "consistent renowned taste and tenderness."



*Adding earlage to a ration increases palatability and gets new feeders to the bunks quickly.*

practice of aging meat the old-fashioned way, hanging it for two weeks, concentrates some of the flavor,” he continues.

With no reason to start taking chances by changing up a winning recipe, Christensen says they will continue to use earlage as part of their overall program. The positives, for this rancher, far outweigh the challenges of the practice.

“We have greater flexibility at harvest, and we handle the harvest less. We need less harvest equipment, and that requires fewer man-hours per bushel. We don’t have to wait for the dew to evaporate in the morning, so we can start at 6 in the morning and finish by 4:30. That leaves more time for family. It just all works together.” ///

“We started selling some of our beef directly to customers,” Christensen says. Those early buyers told him the flavor was superior to what they found elsewhere. He has no scientific proof that earlage plays a role, but he does know a feeding program affects taste and quality.

“It’s possible that this fermented feed (earlage) adds some flavor to the beef. It’s also possible that our

## FOR MORE INFORMATION

Christensen Ranch: [www.christensenranch.com](http://www.christensenranch.com)

**“If we’re being truthful, we’re grass farmers. We manage the land so cattle can harvest it.”**

**KEVIN YON**  
YON FAMILY FARMS, SOUTH CAROLINA



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MODEL: FR1055  
ITEM 69385/62388/62409/62698/30900 shown 13883151  
LIMIT 4 - Coupon valid through 4/15/20

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**CHIPPER/SHREDDER WITH 6.5 HP GAS ENGINE (212 CC)** Customer Rating ★★★★★

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ITEM 62323 13885855  
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**6.5 HP (212 CC) OHV HORIZONTAL SHAFT GAS ENGINE** Customer Rating ★★★★★

**NOW \$99.99** **COMPARE TO \$119.99** **SAVE \$20**

MODEL: GQ200UT20X2  
ITEM 60363/69730 shown 1388305  
ITEM 68121/69727 CALIFORNIA ONLY  
LIMIT 2 - Coupon valid through 4/15/20

**drill master** SUPER COUPON

**1500 WATT DUAL TEMPERATURE HEAT GUN (572°/1112°)** Customer Rating ★★★★★

**NOW \$99.99** **COMPARE TO \$280.6** **SAVE 64%**

MODEL: HG1300  
ITEM 63104/35776/62340/62546/96289 shown 13894088  
LIMIT 3 - Coupon valid through 4/15/20

**PITTSBURGH** SUPER COUPON

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Boom extends from 34" to 45"  
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**NOW \$139.99** **COMPARE TO \$189.99** **SAVE \$50**

MODEL: GP-101040150  
ITEM 69512 61858 shown 13894382  
LIMIT 1 - Coupon valid through 4/15/20

**PITTSBURGH** SUPER COUPON

**12 VOLT, 150 PSI PORTABLE INFLATOR** Customer Rating ★★★★★

**NOW \$69.99** **COMPARE TO \$264.9** **SAVE 73%**

MODEL: 59008  
ITEM 4077/61740/63109/63152 shown 13895860  
LIMIT 5 - Coupon valid through 4/15/20

**luminar OUTDOOR** **SUPER COUPON**

**250 LUMEN POP-UP LANTERN**

Customer Rating **★★★★★**

**NOW \$499**

~~\$699~~

COMPARE TO GO GREEN POWER **\$1499** **SAVE 66%**

ITEM 64110

13896429

LIMIT 5 - Coupon valid through 4/15/20

**HARDY** **SUPER COUPON**

**POWDER-FREE NITRILE GLOVES PACK OF 100**

Customer Rating **★★★★★**

• 5 mil thickness

**NOW \$599**

~~\$799~~

12¢ PER PAIR

COMPARE TO VENOM **\$1497**

MODEL: VEN4145

ITEM 37050, 64417, 61363, 68496, 68497, 61360, 61359, 68498, 64418 shown

13902342

LIMIT 4 - Coupon valid through 4/15/20

**TITANIUM BETTER** **SUPER COUPON**

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COMPARE TO ESAB **\$90260**

MODEL: W1003141

**SAVE \$252**

ITEM 64806

13907721

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~~\$93999~~

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MODEL: K3963-1

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ITEM 63621

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MODEL: 647953

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13912502

LIMIT 2 - Coupon valid through 4/15/20

**Kenway** **SUPER COUPON**

**12 VOLT LED MAGNETIC TOWING LIGHT KIT**

Customer Rating **★★★★★**

**NOW \$2299**

~~\$3499~~

COMPARE TO BLAZER **\$4265**

MODEL: C7300

ITEM 64282

**SAVE 46%**

13919467

LIMIT 2 - Coupon valid through 4/15/20

**HaulMaster** **SUPER COUPON**

**72" x 80" MOVING BLANKET**

Customer Rating **★★★★★**

**NOW \$599**

~~\$899~~

COMPARE TO BLUE HAWK **\$1999**

MODEL: 77280

**SAVE 70%**

ITEM 69505/62418/66537 shown

13923468

LIMIT 4 - Coupon valid through 4/15/20

**CHICAGO ELECTRIC WELDING** **SUPER COUPON**

**WELDING STORAGE CABINET**

Customer Rating **★★★★★**

Welders, tools & supplies sold separately.

**NOW \$14999**

~~\$16999~~

COMPARE TO KLUTCH **\$23999**

MODEL: 48348

ITEM 62275/61705 shown

13927489

LIMIT 1 - Coupon valid through 4/15/20

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MODEL: PCFP02003

**SAVE 59%**

ITEM 97080 shown

13927933

LIMIT 2 - Coupon valid through 4/15/20

**PITTSBURGH** **SUPER COUPON**

**3 PIECE CURVED JAW LOCKING PLIERS SET**

Customer Rating **★★★★★**

**NOW \$699**

~~\$999~~

LIFETIME WARRANTY

COMPARE TO STALWART **\$2999**

MODEL: M550021

ITEM 64036/91684/61249/64035 shown

13931001

LIMIT 5 - Coupon valid through 4/15/20

**Lynxx** **SUPER COUPON**

**40V LITHIUM-ION 14" BRUSHLESS CHAINSAW**

Customer Rating **★★★★★**

**NOW \$14999**

~~\$18999~~

COMPARE TO KOBALT **\$199**

MODEL: KCS120-07

ITEM 64715/64478/63287 shown

13933999

LIMIT 1 - Coupon valid through 4/15/20

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Customer Rating **★★★★★**

**NOW \$2499**

~~\$2999~~

COMPARE TO TIMBER TUFF **\$4999**

MODEL: 399020499

ITEM 63804/40208/61613/63803/68221 shown

13945270

LIMIT 3 - Coupon valid through 4/15/20

**WARRIOR** **SUPER COUPON**

**3 PIECE TITANIUM STEP BIT SET**

Customer Rating **★★★★★**

• 28 unique hole sizes

• 1/4" hex shank

**NOW \$899**

~~\$1399~~

COMPARE TO IRWIN **\$5998**

MODEL: 15504PKSM

ITEM 69087/60379/91616 shown

13952698

LIMIT 5 - Coupon valid through 4/15/20

**HaulMaster** **SUPER COUPON**

**3-POINT QUICK HITCH**

Customer Rating **★★★★★**

• 2000 lb. capacity

• 27-3/16" clearance

**NOW \$19999**

~~\$109999~~

COMPARE TO DOUBLE HH **\$19999**

MODEL: 10712

**SAVE \$120**

ITEM 97214

13954653

LIMIT 5 - Coupon valid through 4/15/20

**WARRIOR** **SUPER COUPON**

**4-1/2" CUT-OFF WHEELS FOR METAL - PACK OF 10**

Customer Rating **★★★★★**

**NOW \$599**

~~\$835~~

COMPARE TO DIABLO **\$1997**

MODEL: DBD045063710F

ITEM 61195/45430 shown

13956663

LIMIT 4 - Coupon valid through 4/15/20

**PITTSBURGH AUTOMOTIVE** **SUPER COUPON**

**LOW-PROFILE CREEPER**

Customer Rating **★★★★★**

• 300 lb. capacity

**NOW \$1999**

~~\$2999~~

COMPARE TO POWER TORQUE **\$4499**

MODEL: GM40300

ITEM 63371/63424/64169/63372 shown

13965839

LIMIT 4 - Coupon valid through 4/15/20

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**2500 LB. ELECTRIC WINCH WITH WIRELESS REMOTE CONTROL**

• Weighs 14.3 lbs.

• 11-1/8" L x 4-1/2" H

**NOW \$4999**

~~\$6999~~

COMPARE TO SUPERWINCH **\$18999**

MODEL: 1125220

ITEM 61258/61297/63476/61840 shown

13969313

LIMIT 2 - Coupon valid through 4/15/20

**BUNKER HILL SECURITY** **SUPER COUPON**

**WIRELESS SECURITY ALERT SYSTEM**

Customer Rating **★★★★★**

**NOW \$999**

~~\$1499~~

COMPARE TO FIRST ALERT **\$3299**

MODEL: SF4600

**SAVE 69%**

ITEM 61910/62447/93068 shown

13979936

LIMIT 5 - Coupon valid through 4/15/20

**PITTSBURGH AUTOMOTIVE** **SUPER COUPON**

**1500 LB. CAPACITY VEHICLE DOLLIES 2 PIECE SET**

Customer Rating **★★★★★**

**NOW \$3999**

~~\$5499~~

COMPARE TO ROUGHNECK **\$8999**

MODEL: 27918

ITEM 60343/67338 shown

13985724

LIMIT 3 - Coupon valid through 4/15/20

**PITTSBURGH** **SUPER COUPON**

**12" RATCHETING BAR CLAMP/SPREADER**

Customer Rating **★★★★★**

LIFETIME WARRANTY

**NOW \$299**

~~\$429~~

COMPARE TO IRWIN **\$1998**

MODEL: 1964718

**SAVE 85%**

ITEM 62123/46807/63017/69222 shown

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# Navigate a Tight Labor Market

*Here are six ways to expand your candidate pool.*

**“For farmers and ranchers looking to hire, we’ve** seen a really big shift in the labor market in the past



LORI CULLER

two years,” says Lori Culler, president and owner of AgHires, and author of the column “Ag’s HR Coach,” featured in *Progressive Farmer* and on **DTNPF.com**. Culler, an agricultural hiring specialist, based in Temperance, Michigan, provided some practical tips for finding employees in this tough labor market to attendees of the

recent DTN Ag Summit in Chicago.

Why the shift in labor? There are three major factors affecting today’s market:

► Low unemployment rates. The lowest rates are in Iowa, New Hampshire, North Dakota and Vermont. There are fewer people looking for a job.

► Compensation rates have notched higher. “What paid \$16 to \$18 per hour five years ago is now paying \$22 to \$28 an hour,” she notes. “Walmart cashiers are paid \$11 per hour, and a diesel mechanic earns \$22 to \$30 per hour.” If you’re not paying the going rate in your community, you won’t find people to work for you, Culler explains.

► The skills of the person you need on your farm have shifted. You don’t need someone who can lift bags and steer a straight row. You need someone who is comfortable with technology and pays attention to details.

## DEEPEN YOUR CANDIDATE POOL

Culler advises farm operators to increase their employee candidate pool. “An ad in the local paper is not going to get you the employee you want anymore,” Culler says. Her advice:

**1 Have a social media presence.** “Seventy-nine percent of job seekers use social media in their job search,” Culler says.

*Hiring through the H-2A program can broaden employee options.*

Michael Yost, who farms near Murdock, Minnesota, agrees that social media can improve awareness of your operation for future employees. One of his employees is a videographer and has posted videos on YouTube. Yost’s farm also has a Facebook page. “You’d be surprised how many hits and messages we get,” Yost says. “People like to watch farming videos.”

**2 Connect with your community college or four-year college.** Yost has a booth at his local community college career fair and has found three full-time employees through it.

Internships for college students are an easy way to test out potential full-time employees, Culler says. Many students can schedule classes so they have full days available to work on the farm during the week.

The key tip here, Culler explains, is to do your hiring in the fall (although the work and pay don’t start until spring). The best college students line up their spring and summer employment the previous fall. “If you missed it this year, wait until fall to hire college students (for the following spring and summer),” Culler advises.

**3 Hire retirees.** Twenty-nine percent of baby boomers (age 65 to 72) were working or looking for work in 2018. ►



JIM PATRICO



*Those who have retired and are looking for work offer another demographic from which to hire.* GETTY IMAGES

“Retirees have their own network. If you hire one person, they may talk others into working part-time for you. We got three to four guys to drive a truck during harvest this way,” Yost reflects.

**4 Hire foreign workers.** Gordon Millar with Red Hen Turf Farm, in Carlisle, Indiana, has hired several employees through the H-2A program. “Harvesting turf is a lot of work,” notes Millar, who has high turnover with American employees. He has hired several South Africans through the H-2A program who come to the U.S. on a part-time basis. “We work with a company in Michigan who coordinates H-2A employees and handles the paperwork. However, we do have to find them housing and provide transportation,” Millar continues.

**5 Look outside agriculture.** “Some of our clients’ best hires have been ex-military, former engineers and former construction workers,” Culler says. “Farm backgrounds are nice, but today, they are not necessary.”

Millar hired one employee who had attended an equipment training school and had worked for a vending machine company. “The most important thing is to find the right personality for your operation. You can train specific skills,” Culler adds.

**6 Make your farm or ranch a place where people want to work.** This sounds obvious, but farmers and ranchers need to take a critical look at how they compensate, train and treat their employees.

“Often, our clients looking to hire an employee are \$20,000 off in what it will take to pay a new hire,” Culler notes. “Rather than start with a lower wage or salary, and increase it only after the employee has ‘proved’ himself, it is better to start with a higher amount to attract the best candidate and let them go quickly if they don’t prove themselves,” she advises.

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“We used to give up to a \$2,000 bonus at the end of the year, but employees wouldn’t consider that when they looked at our hourly rate versus another employer,” Millar explains. “So, we rolled it into their regular compensation. And, we’ve made strong pay increases in the past two years to remain competitive in our area.”

Medical insurance is another important part of compensation. “Our health insurance covers only the employee, not their family. However, several of our employees could find a cheaper plan. So, if they don’t elect to take our health insurance plan, we add that \$4,000 to \$5,000 per year back into their compensation,” Yost explains.

A large Michigan farmer at Culler’s DTN Ag Summit session reported that he pays \$12,000 to \$16,000 per year for family health insurance for each of his full-time employees. And, none of his full-time employees have left in nearly 10 years. “It’s worth that investment for me not to have to hire and train new people,” he says.

## WORK-LIFE BALANCE

In the thousands of job applicants Culler reviews for agriculture clients looking to hire, the applicants are most concerned about work-life balance. “And, they aren’t sure agriculture will offer that,” Culler says.

Here is what agriculture has going for it: It’s outdoor work; employees can see the fruits of their labor; it’s a noble profession to feed the world; and people generally like working for a relatively small but progressive organization.

“However, farmers and ranchers need to understand today’s employees want to spend time with their families and their hobbies,” Culler advises.

“We try to be up front when we’re hiring,” Yost says. “We encourage them to take summer and winter family vacations. But, we need to know well ahead of time when they want to take vacation time. From Labor Day until mid-November, we tell them to expect to be working a lot,” the Minnesota farmer explains.

“We do our best to avoid working weekends. As of yet, we haven’t worked on July 4th, but we have on Memorial Day because it is haying season,” Yost adds. “And, then we have employees that we have to encourage to stop working. Everyone needs a break.”

Adds Indiana’s Millar, “If they want to bring their kids to work, we allow that only after regular working hours from 7 a.m. to 5 p.m. Monday through Friday, mainly for safety reasons,” he says.

Good employees are out there, Culler stresses. But, count on it taking more time, compensation and flexibility than you thought to find them. However, finding the right employee who “fits” your operation will make you money in the long run, she concludes. ///



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# Don't Fear The Venture Capitalist

*Outside investors don't necessarily want farmland. Many are looking for rural businesses with great ideas.*

**Rural America is ripe for investment. Yet, barriers** to capital markets, including a fear of venture capital, have led to a gap in financial infrastructure that makes it more difficult for private dollars to finance new opportunities.

“The normal rules that we’re taught in business school and college, and in our professions don’t seem to work across broad sections of rural America,” points out Matt McKenna, who focuses on recruiting private-sector investment in the rural economy through the Rural Opportunity Initiative at Georgetown University.



*Matt McKenna, executive-in-residence at Georgetown University and venture capital investor, suggests barriers cause rural America to struggle to attract private-equity investment.* JOEL REICHENBERGER

In general, farms aren't the type of businesses most venture capital firms are interested in. Instead, most are looking to invest in an idea with high potential for growth.

## BARRIERS TO OVERCOME

During a presentation at the recent DTN Ag Summit in Chicago, McKenna explained the perennial challenges investors run into when trying to finance rural America:

- conservative borrowers
- a gap in financial awareness
- scale

A prime example of the conservative nature of rural America is water loans financed through the Rural Development branch of the USDA. McKenna explains it costs, on average, \$5 to \$6 million for a rural town to convert from well to tap water, which has been proven over time to attract new economic activity, such as new businesses and housing. A bank loan for that type of project might carry an interest rate of 7 to 8% compared to the 2 to 3% USDA can offer because of the government's subsidization. It's a difference of about 400 basis points, McKenna explains.

“From my point of view, that's pretty close. Nonetheless, the waiting list for these loans is almost five years long,” he explains. “The low cost was more important than the long-term benefit.”

In addition to a willingness to wait for attractive federal financing, McKenna says rural borrowers, generally speaking, don't spend much and would rather

not borrow money if they don't have to. They'd also rather not incur a long-term debt obligation when short-term will do. That makes a tough nut for venture capital to crack.

Financially, there's a knowledge gap in rural America, McKenna adds. It's not uncommon for small businesses to have higher valuation expectations than venture capitalists. For example, Open Prairie, a private-equity fund in which McKenna is a partner, considered investing in an aquaculture business that used unique technology. The family that owned it, however, thought it was worth far more than Open Prairie

did, so the deal didn't go through.

Another problem is board seats. Most venture capital investors want to have an advisory role, something McKenna has seen sink deals in the past. Investors also have to comply with certain reporting requirements and need to require regular financial statements, which often pose another hurdle.

“I don't blame the investment itself. I don't blame the entrepreneurs. I don't blame bankers. What I blame is a disconnect between the financial resources and the information available, and the awareness of it,” McKenna explains.

## SHOW ME THE MONEY

The third problem is one of scale. Many venture capital investors are large, with hundreds of millions of dollars

to spend. They're often more than happy to make a \$500-million loan but can't justify a \$5-million loan. "They can't dip to that level because it would require too many transactions to fill their portfolio needs," he notes.

Despite the barriers, McKenna argues private-equity financing has an important role to play. A study by the Brookings Institution found that 80% of small community banks have closed since 1996. At the same time, larger lenders have stepped away from small business loans.

"From a financial infrastructure perspective, this means working capital loans are difficult to get. Long-term financing is difficult to get unless you're borrowing to buy a tractor or borrowing to buy a home," he says, adding that terms offered to rural businesses may not be as competitive as what their urban counterparts can secure.

"Yet at the same time, you read in the paper that investable dollars are at an all-time high, as if there's a mountain of money waiting to be invested,"

McKenna continues. Right now, 80% of those dollars is invested in Boston, New York and San Francisco, according to a recent study by the National Venture Capital Association.

Nonprofits like Rural Opportunity Initiative are already working to ease the education gap and build

awareness, McKenna says, but they can only do so much. "The financial infrastructure can only really be built by the private sector," he contends.

Farm Credit banks are already a step ahead of

others with their local footprints, but McKenna expects financial technology to make waves in rural financing, too. "J.P. Morgan isn't going to start opening branches downtown, but J.P. Morgan will make credit available through a technology platform that's just being rolled out right now."

A variety of other players are also trying to address rural investment needs. USDA chartered the Rural Business Investment Company, which was financed with private capital. There are multiple private-equity funds like Open Prairie that look specifically to invest in rural projects. Some investors are getting over the problem of scale by combining several projects into one venture.

McKenna is optimistic about the future of venture capital

and private investment in rural America. "That fear and that wariness (about venture capital) is largely attributable to a lack familiarity, to a feeling that, 'What am I going to lose,' as opposed to 'What am I going to gain?' And, the way to make that conversion is by education, experience and awareness." ///

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# Farm Smart With Living Mulch

*Legume-corn system cuts expenses, nitrate loss and weeds.*

**Call them perennial optimists—farmers who** are using Kura clover perennial legume living mulch to farm smarter.

Between corn rows, it provides nitrogen (N), crowds out weeds, improves soil structure and drainage, and reduces water runoff and soil erosion. In a rotational-grazing system, it's a durable, high-protein forage.

Kura clover propagates itself by rhizomes (underground stems, such as quackgrass) and is long-lived and cold- and drought-tolerant. Its extensive perennial root system sustains diverse soil microbes that improve nutrient recycling and soil water drainage/storage.

In wet springs such as 2019, it broadens farmers' options by improved soil-moisture infiltration and earlier spring fieldwork.

"Kura farmers are thinking of a triple bottom line," says Scotty Wells, University of Minnesota agronomy and plant genetics assistant professor. He's the principal investigator of a Minnesota citizens committee for water-quality improvement. "They're also thinking about their sustainability."

Before the Haber-Bosch process of inexpensive synthetic ammonia-fertilizer manufacturer from nitrogen and hydrogen was invented in 1909, legumes were the conventional way of providing nitrogen for crops along with manure.

## SLEEPS, CREEPS AND LEAPS

Fred Abels, a diversified Holland, Iowa, strip-tiller, established kura perennial clover 13 years ago as part



UNIVERSITY OF MINNESOTA

of an Iowa State University on-farm research trial. After two years' establishment, kura "sleeps, creeps and leaps," he says.

"By that, he means that kura, when first planted, appears to grow very slowly because it puts most of its biomass into the root system," says kura researcher John Baker, USDA-ARS, St. Paul, Minnesota.

"Consequently, a first-year kura field will be rather weedy (first it sleeps)," he explains. "However, in the second year, it spreads by rhizomes and comes back stronger with each mowing, gradually displacing the weeds (then it creeps). By the third year, the kura's growing vigorously (then it leaps) to life and provides a vigorous and persistent stand of high-quality forage and living mulch between cash crops."

Improved kura varieties such as Everlast have boosted seedling vigor, says longstanding kura researcher Ken Albrecht, University of Wisconsin (UW). He helped develop the kura living mulch rotation with corn about 25 years ago, along with his graduate students. ▶

□ *Kura clover's extensive perennial root and rhizome system accounts for its mat-like habit.*



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The goal was to have a perennial N source for interseeded corn crops and living roots during the full year to anchor soil and nutrients.

Kura's dense root and rhizome system is resilient, even after intentional herbicide defoliation used to suppress competition with cash crops seeded into kura living mulch.

Kura continues to stand up well in areas of heavy cattle traffic and rotational grazing after 13 years, says Abels, the Iowa kura grower. He seeded his initial stand with two other cool-season perennials, Palaton low-alkaloid reed canarygrass and birdsfoot trefoil.

Abels farms about 400 acres of corn and soybeans, manages hay pastures and has a cow/calf operation with a rotational-grazing system.

Northern Minnesota farmer Troy Salzer planted 20% of his pasture to perennial kura clover 19 years ago, and, "it's been extremely productive over the years." He wanted a durable perennial cattle forage for his high-water-table soils and rotational-grazing system.

"Kura requires up to two years and some patience to establish, but then it's extremely durable and provides legume nutrients for livestock or subsequent corn crops," Salzer says.

Similar to Abels, he established kura with Palaton low-alkaloid reed canarygrass and birdsfoot trefoil. His kura and canarygrass are still doing well.

### STRONG POTENTIAL

Kura clover living mulch systems have such economic and environmental potential that they've attracted scientists at the universities of Iowa, Minnesota and Wisconsin, and USDA-ARS for 10 to 25 years. They see the kura-corn cropping system as an economical, sustainable way to reduce nitrate and soil loss, reduce commercial inputs and diversify rotations.

Decades-old kura clover research stands grow so vigorously between corn rows in season that it's typically mowed, strip-tilled and sprayed with Roundup at 1 quart per acre to knock it back and lessen its competition with emerging corn seedlings.

"Kura holds on throughout the season after intensive spring management and in the low light under the corn canopy," says Jonathan Alexander, whose University of Minnesota Ph.D. defines N-management recommendations for kura clover-corn systems. He's collaborating with USDA-ARS adjunct professors John Baker and Rodney Venterea, and University of Minnesota corn systems Extension agronomist Jeff Coulter.

Kura pastures at the UW-Lancaster Agricultural Research Station are 24 years old and counting, compared to three or four years' life span for red clover and alfalfa, Albrecht says.



Minnesota farmer Troy Salzer's 19-year-old kura perennial clover stand works well for his rotational-grazing system.

For these reasons, it's "also well-suited to remediating wellhead nitrate contamination," Wells adds. "The kura system is strategic with high-value ecologic services."

### COST REDUCTION

Central-Minnesota farmer Jon Stevens will use kura to farm more profitably and sustainably. Once it's established, he'll use it as free N one year for corn and then as a hay crop the next.

The Rock Creek farmer plans to drill kura in spring 2020 on 60-inch rows into a multiclover mix that nurses the kura for two years. The following spring, he'll bale the kura then strip-till corn into the standing kura/clover mix. Cutting the kura before planting reduces competition with the corn crop. After corn harvest, "we'll have another cutting of phenomenal feed value," Stevens says. "It's all about farming more profitably." His goal is to get two or three cash crops across the farm.

Stevens plans on \$200-per-acre revenue from baled kura/corn stover and an estimated \$75-per-acre savings in commercial N for first-year corn grown among kura. Second-year corn in the living mulch system requires fertilizer N at a similar rate to conventional corn following soybean, University of Minnesota's Alexander explains. Stevens counts on 130-bushel corn yields in 60-inch rows.

In his central-Minnesota location, Stevens' research finds that kura will survive or thrive in conditions where alfalfa has winter-killed or drowned out.

His vision is having options in variable weather events. "In very wet springs like 2019, established winter wheat, rye and hay crops provide more options." ///



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# Distress on the Farm

*Difficult years increase challenges, but there are multiple ways to deal with the stress.*

## Stress on the farm is hard to avoid with the

numerous challenges farmers had to deal with in 2019. From the many weather challenges during the growing season to the various production risks producers faced because of this situation, last year was a stressful one for many in agriculture.

Long-term stress is bad for one's health, both physically and emotionally. Those who are struggling with stress should not be ignored. However, there are actions and activities that can be taken to help reduce stress.

## TWO TYPES

There are two types of stress, according to experts in a recent "Keep Stress Levels in Check on the Farm" webinar put on by the University of Nebraska-Lincoln (UNL) Extension. Glennis McClure, a UNL Extension educator, says eustress is good stress, while distress is bad stress.

Eustress is short-lived but motivates people, improves performance and can give an individual a feeling of excitement. Receiving a work bonus or getting married are just a few examples of good stress.

Distress can be bad if the amount of time it is present is fairly long. Prolonged stress affects the body, mind and one's actions, she explains.

Chronic stress creates high levels of cortisol in the body, which increases blood cholesterol, triglycerides and blood pressure, which can cause heart disease, she adds.

"Long-term stress can affect how the blood clots," McClure says. "This makes the blood stickier and increases the risk of stroke."

## LESSEN EFFECTS

There are several things farmers can do to lessen the effects of stress, says Brandy VanDeWalle, a UNL Extension educator.

One practice is to build gaps into the day to ensure you have time for a mental break. Another would be to be more assertive and perhaps say no to events and activities that add to your already-full schedule, she says. Other practices to lessen stress include learning to take time off, getting exercise during the course of the day and having someone to talk to.

"This could be a family member or a friend to talk to, or maybe this could even be journaling," VanDeWalle says.

Those who are under stress need to cultivate a productive mindset, McClure continues. Utilizing self-



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talk can help in this process. Choose three words to help maintain a positive mindset. "I would choose calm, capable and controlled," McClure says.

Practices for maintaining a productive mindset include breathing and acceptance, she adds. Deep breathing gives you a time to pause and accept your situation, then begin working on a solution to your problems.

## WATCH OTHERS

Everyone handles stress differently, and some people do not handle stress as well as others. If you come across someone in distress, there are things to do to help this person, McClure explains.

Once you recognize signs of distress, express your concerns to the person and ask about their situation, she says. If they express suicidal thoughts, take action immediately.

"Any suicidal talk or behavior must be treated as serious, and do not leave the person alone," McClure says.

Many people believe if you ask someone about suicide, this puts the thought into the person's mind. This is a myth, and talking about it does not increase the chances of it happening, she explains. ///



## FOR MORE INFORMATION

- ▶ The National Suicide Prevention Lifeline: **800-273-8255**
- ▶ Federal Substance Abuse and Mental Health Services Administration: **800-662-4357 (HELP)**
- ▶ University of Nebraska-Lincoln (UNL) Extension Website for Rural Wellness: [ruralwellness.unl.edu/resources](http://ruralwellness.unl.edu/resources)

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# Positive Projection

*Global nutrient supply increases to meet growing demand.*

**Editor's Note:** Analysts gathered in Savannah, Georgia, late last year for the 2019 Fertilizer Outlook and Technology Conference to discuss what's in store for crop nutrients. The conference is held by The Fertilizer Institute and the Fertilizer Industry Round Table. This is a summary of the outlook reports for supply and demand.

**Global fertilizer demand is increasing, and this rising demand requires growth capacity in the industry.** The need internationally for more fertilizer presents some major challenges as farmers attempt to feed a growing world population.

Michel Prud'homme, retired from International Fertilizer Association (IFA), gave the global nutrient supply outlook. While one would expect many positives with the industry growing, there are some potential issues in the world fertilizer supply.

## DEMAND RISING

Because of increasing international demand for nutrients, world fertilizer capacity will have grown by 66% between 1990 and 2022, Prud'homme says. Specifically, during that same period, nitrogen increases 56%, phosphoric acid is up 90% and potash rises 78%.

From 2000 to 2017, he continues, nitrogen saw large increases in production from Central Asia (EECA), China, Eastern Europe and West Asia. Then, from 2015 to 2022, the world supply forecast is for significant reductions in Chinese production, which is being offset

slightly by increased production in Africa, India, Russia and the U.S.

Ammonia capacity relates to natural gas reserves, and the top five largest natural gas reserves (U.S., Russia, Iran, Qatar and Saudi Arabia) have 25% of the world anhydrous ammonia capacity. The U.S. is the new natural gas supplier with newer nitrogen fertilizer capacity.

Other countries such as Africa, EECA and West Asia have potential growth for future nitrogen fertilizer capacity, he added.

Global ammonia capacity is expected to increase from 220 million metric tons (mmt) in 2018 to 228 mmt by 2021, a 3% increase in the world ammonia supply, he says. China's production is forecast to decrease 6% to 62.3 mmt from 2018 to 2021, which would be only 28% of the world's capacity—down from 30% in 2018.

Prud'homme says the urea capacity is expected to increase from 210 mmt in 2018 to 222 mmt in 2021.

What is going on in China and India with urea capacity is the opposite end of the spectrum, he notes.

China has urea capacity dropping by 2.7 mmt from 2018 capacity to 65 mmt in 2021 due to facilities closing in the country because of increasing environmental regulations. This correction will result in 16 mmt less in production in 2021 than what it was in 2014.

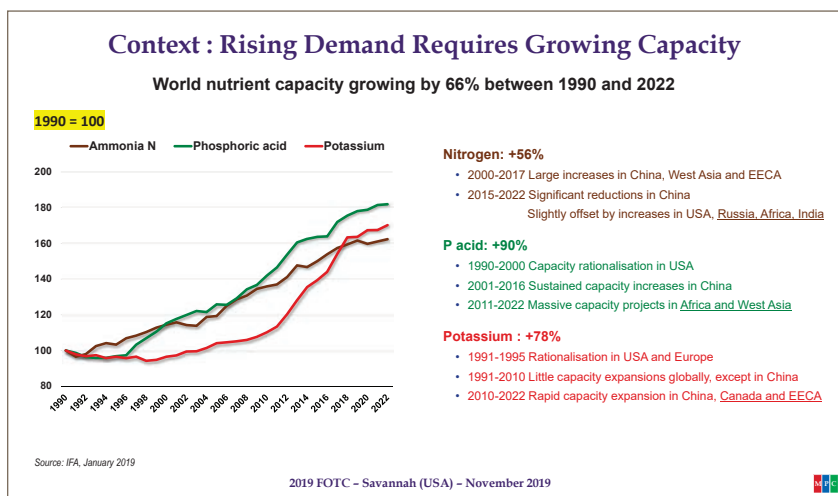
India, meanwhile, is set to see urea capacity surging during the next five years. Five new urea plants in the nation will increase India urea production by 6.4 mmt to 31.2 mmt in 2021, he says.

“Urea imports are expected to drop from 8 mmt to around 2 mmt in 2021,” he says.

Phosphoric acid saw increased supply from 2001 to 2016 from sustained capacity increases in China, he says. Also, massive capacity additions were made in Africa and West Asia.

The top three phosphate rock reserves (China, Morocco and U.S.) produce 63% of the global rock capacity. Phosphoric acid capacity is expected to increase from 60 mmt in 2018 to 61 mmt in 2021.

Potash had very little capacity additions from 1991 to 2010. Then, in >



*The world's nutrient capacity is expected to increase by 66% from 1990 to 2022.*

GRAPHIC COURTESY OF MICHEL PRUD'HOMME

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the forecast from 2010 to 2022, there's a rapid capacity expansion in Canada, China and EECA.

The world potash capacity supply is expected to increase from 95 mmt to 99 mmt in 2021. Production rationalization—decreases—are expected in the European Union, while increases are expected in Belarus and Russia.

**SUPPLY DRIVERS**

Prud'homme says there are three main drivers for global fertilizer supply.

The first factor is if a region has the natural resources to produce fertilizer. Access to feedstock supply, such as natural gas, is necessary, as is a good economic and financial situation, he says.

The second driver is regulations. This could be either environmental and/or product safety.

The third driver is policies by the regions for fertilizer supply. Trade policy, export taxes and domestic investment policies are all included in this driver.

"The availability of state-of-the-art technology is also fairly important," Prud'homme notes.

One specific challenge the global fertilizer industry faces is to supply the market but not to get into an oversupply situation. Basic economics says too much supply will lessen the demand of a product, and fertilizer is no different, he says.

Global fertilizer operating rates from 2011 to 2015 declined in all segments until about 2014, he says. Potash had rate recovery starting in 2014, while urea and phosphoric acid saw rate recovery by 2015.

Then, during the 2015 to 2018 time period, lower operating rates were again seen in all nutrients.

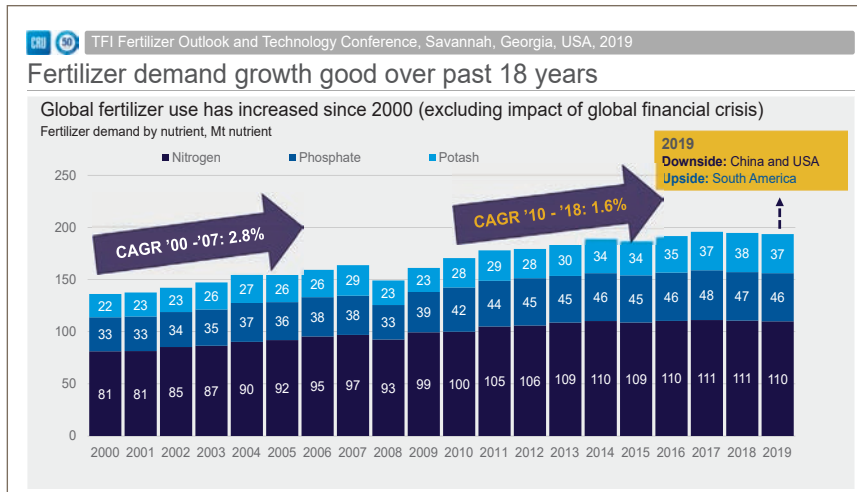
Lower global ammonia and urea capacities were seen from 2017 to 2019. Phosphoric acid and potash capacities saw capacity rising faster than production from 2015 to 2016.

In addition, low operating rates on capacity and effective capacity were seen in the potash segment.

**REBOUND AHEAD**

A strong rebound in global fertilizer demand in 2020 is expected with more acres planted in the United States, according to Rajiv Ram, senior analyst of agriculture and fertilizer demand for CRU Int. Ltd. Despite this positive outlook, some risks from across the world threaten to alter this forecast.

Ram says 2019 had several challenges to demand from uncooperative weather to trade disputes. However, the demand prospects for 2020 look to improve.



Global fertilizer use has increased every year since 2000, minus the global financial crisis of 2008 and 2009. World fertilizer demand is expected to be just under 200 million metric tons in 2019. GRAPHIC COURTESY OF RAJIV RAM

Global fertilizer demand has seen good growth since 2000, excluding the impact of the global financial crisis of 2008 and 2009. The world fertilizer demand in 2000 was about 140 million metric tons (mmt), and by 2018, this number was just under 200 mmt.

Ram says the global fertilizer demand number will be right around 200 mmt for 2019. No growth was seen for two main reasons, he says.

The first reason is due to fewer planted acres in the U.S. in 2019 because of the extremely wet weather. Fewer acres planted led to fewer acres needing fertilizer applications.

The other reason for the steady fertilizer demand seen in 2019 was issues with fertilizer demand in China.

Ram says China's share of the global nutrient demand is large but falling. China's nutrient demand in 2018 was 200 mmt, around 30% of the global demand; but by 2024, the number might drop closer to 25% of the global fertilizer market.

"There are several factors of why there is weakness in China," Ram says. "Unsupportive crop market fundamentals, falling application rates, increasing farm size and efficiency, and changing fertilizer practice are all reasons for less Chinese demand."

China's fertilizer demand is evolving rapidly as falling nutrient demand is being seen on crops, but it is being offset by increased applications on fruit and vegetable area. Overall, Chinese nitrogen and phosphate demand is falling and is forecast to continue to fall in the future, but potash use is rising, he says.

In 2018, nitrogen demand in China was at 25 mmt while phosphate was at 10 mmt. Both nutrients are expected to fall looking out to 2024, he notes. Potash is ►



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at just 10 mmt in use in 2018, and by 2024, this number could be more than 10 mmt.

### 2020 BETTER FOR DEMAND

Ram says looking ahead to 2020, the global fertilizer demand outlook appears to be better, led by a strong rebound in U.S. fertilizer applications.

The U.S. fertilizer demand in 2018 was near 34 mmt but dropped to around 32 mmt in 2019, he says. The forecast for 2020 is back around that 34-mmt level.

U.S. corn plantings are projected to jump in 2020, thus boosting demand for fertilizer, Ram says. Corn acres in the U.S. in 2019 were pegged at 89.9 million acres, and for 2020, this number could be closer to 93 million acres, he says.

One reason for the expected U.S. rebound in fertilizer demand in 2020 is fertilizer affordability indexes (an index of fertilizer and crop prices) are very favorable right now. DAP (diammonium phosphate) has never been more affordable, while urea is becoming more affordable along with ammonia and potash, he says.

Ram says another positive situation in global fertilizer demand is India's increasing use of urea fertilizers. While sales of DAP and potash were down, comparing the January-to-October period in 2018 to the same period in 2019, the sales number for urea increased by 12%, he says.

"Key developments include greater efforts to streamline the fertilizer sector in recent years, it was an election year, and a late-season monsoon helped to boost the rabi season," he says. "India's love affair with urea shows no signs of stopping."

### GLOBAL ISSUES

Ram says there are some issues that threaten to cloud the bright fertilizer-demand picture.

Hovering over the global fertilizer-demand market is the chance of a U.S. recession, which would lower

the demand for fertilizer. A CRU survey asked what the probability is of a U.S. recession in the next four quarters, and 43% responded the chances were 25 to 50%, he says.

An economic slowdown is a downside risk for U.S. fertilizer demand. Changes to economic growth affect nutrient demand as the last major recession in 2008 and 2009 pulled down the global nutrient demand, he says.

The other issue worth watching would be what happens with the U.S.-China trade war. One interesting aspect of the dispute is it has bolstered Brazilian fertilizer demand, he says.

With China purchasing more soybeans from Brazil, this caused a premium on the world market for Brazilian soybeans, Ram says. The Brazilian cropping areas continue to increase, a feature that was present before the trade dispute but a number that is only set to increase.

As a result, Brazilian demand for fertilizer is expected to climb for the fifth consecutive year in 2020, close to 30 mmt. In 2010, it was 15 mmt.

### MEDIUM- AND LONG-TERM

Global fertilizer demand in the medium-term (from 2019 to 2024) is expected to see some growth. Fertilizer demand by 2024 could be over 200 mmt, with nitrogen seeing 1.2% growth, phosphates 1.7% and potash 1.8% yearly growth.

Ram says the largest volume change in fertilizer demand is expected to come in South America. The continent could see an additional 5 mmt of fertilizer demand added from 2019 to 2024, he says.

Meanwhile, Africa is expected to see high rates of growth in fertilizer demand, possibly a 5.5% increase in fertilizer demand. Other countries with high rates of growth include South America (3.8%) and Southeast Asia (3.2%), he says.

The long-term outlook (2024 to 2042) calls for increased efficiency measures in some regions. This might be slightly lower usage in Eastern Asia, North America and Western Europe, but it will most likely be offset by rising fertilizer demand in other regions, such as in Africa, Eastern Europe and South America.

Ram says these long-term changes will mean changes in market shares in the future.

Regions like Europe (17% in 2000 and 12% in 2040) and North America (16% in 2000 and a forecast of 10% in 2040) could see smaller shares of the global fertilizer demand. Meanwhile, other regions such as Africa (3% in 2000 and 7% in 2042) and South America (7% in 2000 and 16% in 2040) could see some gains in demand, he says. ///



JIM PATRICO

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