Managing potassium, phosphorus when prices are high

Drainage water recycling systems improve corn yields

Plan now for antibiotic changes on the horizon

Missouri freezing temperature trends

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THE EARL FARRIS farm just outside the city limits of Owensville is the backdrop to this 2021 harvest scene in early November. Cody Sassmann shells corn approaching his turn-around point approaching Route P.

PHOTO BY DAVE MARNER

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GASCONADE COUNTY Republican

Drainage water recycling systems improve corn yields

MISSOURI FARMERS are always looking for methods to improve their cropland yields from creating field drainage systems to eliminate wet spots up to water recycling projects to make the most of limited rainfall in dry times.

PHOTO BY DAVE MARNER

BY LINDA GEIST
University Extension

A recent report through the Transforming Drainage project shows that drainage water recycling systems can improve corn yields and the environment, says University of Missouri Extension agronomist Kelly Nelson.

Nearly two-thirds of the site-years evaluated in the studysaw an increase in yield compared to free drainage, with an overall average yield increase of 19 bushels per acre. The study looked at data from seven sites in the Midwest. These included silt loam fields in Shelby and Knox counties in Missouri, which are part of MU's Lee Greenley Jr. Memorial Research Center, as well as two sites in Minnesota and three sites in Ohio.

Researchers found that drainage recycling systems reduced yield variability by 28 percent over 53 site-years of work. This increases the resilience of the crop system and improves food security, Nelson says.

A combination of drainage and subirrigation also protects the environment by keeping nutrients such as nitrogen and phosphorus from entering downstream waterways, he says. That nutrient-rich water is recycled through irrigation.

Closed-loop drainage control systems capture and store surface and subsurface drainage water in a reservoir and then reuse that water as supplemental irrigation. Water level control structures—boxes with slides or gates that are buried in the ground—are spaced through water management zones based on the field's slope. Flow is adjusted to retain or drain water based on precipitation and the growth stage of the crop.

Researchers also found that corn yields gain most in the second half of vegetative development (9-leaf and greater) to early grain filling (blister stage). They found no yield difference between free drainage and drainage water recycling before the V9 stage or after R2.

Yields increased most in dry years when corn was most vulnerable to water stress and lower yields. Drainage water recycling likely improves corn yield in years when precipitation is below the critical threshold of 5 inches during the V9-R2 period and during extreme temperatures.

Soil characteristics play a major role in yield benefits of drainage water recycling, Nelson says. Deep soils with high water-holding capacity are less likely to be affected by short, dry periods during critical crop growth stages and may benefit less from irrigation. Soils that hold less water include shallow soils and sandy or clayey soils.

During a recent field day at MU Greenley Research Center, extension agronomist Kelly Nelson presents results from a new report showing that drainage water recycling systems can improve corn yields and protect the environment.

PHOTO COURTESY OF LYNN BRADLEY

Because soil plays such an important role, Nelson recommends the Subirrigation Site Suitability Tool at transformingdrainage.org/tools/subirrigation-suitability-tool to help with initial planning.

The report was written by collaborators from MU, Minnesota Department of Agriculture, Purdue University, University of Wisconsin-Green Bay, USDA Agricultural Research Service (ARS) and the agricultural biotechnology company Benson Hill. Nelson, Lori Abendroth of the USDA-ARS in Columbia and doctoral student Rebecca Willison worked on the research for the publication.

The report, "Corn Yield Response to Drainage Water Recycling Using Subirrigation," is available for download at bit.ly/3sPU8MH.

Learn more about the Transforming Drainage project at www.transformingdrainage.org.

Pasture and cattle management strategies for a successful summer grazing season

BY PATRICK DAVIS
University Extension

Proper management of cool season pastures and incorporation of summer annuals is key to a successful summer cattle grazing season. Efficient year-round cattle grazing is important for optimum cattle operation profitability.

Strive to keep cool season pastures vegetative. During the grazing season, cool season grass heights should range between 4 to 8 inches. During the summer months, cool season forages will sometimes exceed this range or seed heads will start to develop. Forage in this growth stage is low quality and will not provide optimum cattle grazing intake and performance. Davis urges cattle producers to clip or mow pastures that are too tall or if seed heads are emerging to reset the pastures which allows for high quality cool season forage regrowth.

Seed summer annuals now to strengthen the summer grazing rotation. Crabgrass, pearl millet, and sudangrass are summer annuals that can be seeded now and grazed in the summer months to fill in the cool season grass slump. Cattle producers are urged to checkout MU Extension Guide Sheet G4661 as well as visit with your local MU Extension agronomy field specialist to discuss proper seeding and establishment of these summer annuals.

Begin grazing crabgrass at 8 to 10 inches and don't graze lower than 3 inches. Crabgrass can typically be grazed approximately 30 to 45 days after planting.

Begin grazing sudangrass at a height of greater than 24 inches to prevent prussic acid poisoning in cattle. Since pearl millet does not cause prussic acid poisoning in cattle, begin grazing it at a height range between 18 to 30 inches. Do not graze either of these forages below 10 inches. Both of these forages can typically be grazed 45 to 60 days after planting.

Nitrate toxicity can be an issue with sudangrass and pearl millet during summer drought. Contact your local MU Extension livestock specialist for cattle and forage management strategies to reduce potential nitrate toxicity issues.

For more info or questions on how to manage your forage program for a successful summer cattle grazing season contact your local MU Extension Agronomy and Livestock Field Specialists.

Managing potassium, phosphorus when prices are high

BY LINDA GEIST
University Extension

COLUMBIA — Farmers understand fertilizer prices fluctuate with time. "We are living through a substantial shift in potassium and phosphorus prices, from low prices in the 2020 growing season to the highest prices in the past decade for fertilizer purchased now for the 2022 growing season," says John Lory, University of Missouri Extension nutrient management specialist.

A frequent question when high fertilizer prices shock the system is whether phosphorus and potassium applications can be delayed until next year when prices may be lower. The quick answer is yes—if your soil test levels are near recommended levels, says Lory.

"Soil test P (phosphorus) and K (potassium) levels act somewhat like a gas gauge on a car," he says. "If your gas tank is full, you know you can travel 500 miles before the tank runs dry. If you are making a trip that is 200 miles, you can, with confidence, make that trip once without refilling your tank. The second trip is also likely fine. But you know you will need to refuel before completing the third trip."

A soil test result at or above recommended levels is much like a gas gauge reading full. On most Missouri fields, an optimum soil test level indicates you should be able to plant multiple years of crops without refilling the tank. You should be fine skipping one year. Many farmers already apply P and K alternate years. But if you did not apply last year, can you take another year off? The way MU Extension's recommendation system is designed, one more year should not be a problem, says Lory.

What are options for managing high fertilizer prices?

Lory outlines options for reducing fertilizer costs this year:

• Do not apply fertilizer to fields that are at or above optimum soil test levels. Extensive research shows that soils at optimum soil test levels do not see increases in yield from the fertilizer applied that year. A benefit of following soil tests is the flexibility to skip a year of application. Why not take advantage of this benefit in a year when the price is high?

• Not comfortable with going to zero? A second option is to cut fertilizer rate by 50 percent or less of removal rate. Most yield response to fertilizer is driven by the first 30 percent to 50 percent of the fertilizer applied. If you are nervous about going to zero, going halfway will likely provide 100 percent of the yield benefit this year, even on soils that tested low.

• The most conservative option is to limit fertilizer rate to removal rate. In a high fertilizer price year there is no reason to apply more than the crop removal rate. "If your field happens to be responsive to added P and K this year — a big if! — crop removal rate is guaranteed to maximize yield," says Lory.

There is another option to reduce your fertilizer bill and learn about fertilizer response on your fields, says Lory. Work with the "MU Certified" Strip Trial Program and put strips with and without either P or K.

If you use this strategy on the whole field, the amount applied will drop by 50 percent. Strip trial program participants will work with Lory and his team to document if fertilized strips have higher yield than the unfertilized strips.

"Our expectation is a field with optimum soil test will have no increase in yield on the fertilized strips," says Lory. "This test confirms MU Extension recommendations are working as expected on your field and contributes to a statewide effort to document fertilizer responses on Missouri farms."

If you are interested in strip trials, contact your local

See **Potassium**, Page 6B

Potassium • *from page 5B*

MU Extension agronomist or agricultural engineer, or visit striptrial.missouri.edu.

There are situations where soil test recommendations may not fully identify fertilizer need. Lory has seen potassium deficiency symptoms in highly compacted areas of the field because restricted root growth prevents the plant from getting to the potassium in the soil. Cool soils also can temporarily limit the availability of phosphorus.

"Often these conditions lead to transient deficiency symptoms that the plant grows out of as soils warm and become less saturated," says Lory.

Finally, sandy soils and soils with low organic matter may not have the same capacity to withstand multiple years with no fertilizer application; they have a smaller gas tank, he says.

Fertilizers help sustain crop production. Soil testing helps farmers understand the nutrient status of soils. "When fertilizer prices are high, we can also use soil testing to understand the risks of not applying fertilizer," Lory says.

MU Extension launches "Mizzou Crop & Pest News"

COLUMBIA — University of Missouri Extension has launched Mizzou Crop & Pest News, an electronic newsletter for agriculture professionals and extension specialists that provides information on current agronomic challenges.

Mizzou Crop & Pest News is an updated version of the Integrated Pest & Crop Management (IPCM) newsletter. The new format will provide readers with more concise information, including estimated read times and one-sentence summaries of articles, said Mandy Bish, MU Integrated Pest Management coordinator.

"The idea to launch Mizzou Crop & Pest News stemmed from a 2021 survey of over 500 Missouri professionals in row crop production," Bish said. "Respondents ranked electronic newsletters as a highly preferred source of information and indicated extension as the most trusted source."

Bish said the newsletter will include new topics as well as content that subscribers to the IPCM newsletter have come to expect, such as state extension weed specialist Kevin Bradley's weed management articles.

"We believe that this newly formatted newsletter will prove to be a valuable source of information for producers and other agricultural professionals throughout Missouri," Bradley said.

"We have a series of 'Top Three' newsletters lined up for early March," Bish said, "and we plan to include info on crop insurance considerations, climate, mental health resources and more. These are topics that go hand in hand with crop production and pest management but have not traditionally been covered in the newsletter."

Following the "Top Three" series, the newsletter will be published as questions and needs arise throughout the season, she said.

To sign up for email notifications when new issues are published, visit ipm.missouri.edu/subscribe or email ipm@missouri.edu.

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How to incorporate tech into a farming business

The agricultural industry long has been a vital part of society, providing foods for billions of people across the globe. Farming can be a challenging profession, and farmers routinely find creative solutions to overcome obstacles to effective production. Thanks to technology, finding solutions has become that much easier.

Yet not every farmer who is set in his or her ways is ready to welcome changes that incorporate technology right away. In fact, reluctance to turn over operations in some part to artificial intelligence or smart technologies could be due in part to farming being such a nuanced skill and the role intuition plays in the growth of crops. The following are some ways for seasoned and novice farmers to seamlessly incorporate technology into their operations.

Start with peripheral tech

Farmers can begin implementing technology that does not directly relate to farming operations. Examples include switching to efficient and intuitive accounting and payroll systems to save time. If a farm also includes a retail enterprise, such as a farmers market, upgrading point-of-sale technology, like credit card readers or e-commerce websites for new revenue potential, can be good a good starting point.

Assess operation weaknesses

Figure out where the business is lacking and could use some help. Perhaps you're having difficulty maintaining adequate irrigation or plant nutrition is compromised due to soil deficits? Precision automation farming advancements that employ remote sensors can assess conditions and fine tune adjustments to alleviate these issues.

Get training

Novel technologies can increase crop yield and make for more efficient use of limited resources. However, people who may never have employed drones, IoT devices or soil sensors can expect a learning curve. Visiting a nearby farm operation to learn how they have implemented technology and gaining hands-on experience can be invaluable. In addition, request that a tech vendor provide thorough instruction on products to make it easier to seamlessly integrate new technology into an agriculture business.

Tap into workforce talent

The Food and Agriculture Organization of the United Nations says agriculture and food production accounts for 28 percent of the entire global workforce. There are more than 570 million smallholder farms worldwide. Technology can be utilized by agricultural businesses to zero in on intelligent and qualified employees who can take operations to the next level. Websites like Glassdoor, Indeed and ZipRecruiter remain helpful tools when looking for qualified job candidates. The internet is an essential employment resource, and farms can utilize it to acquire new hires.

Agricultural businesses can explore various ways to gradually and seamlessly make technology part of their operations.

Proper management to reduce the incidence of grass tetany in your cattle operation

BY PATRICK DAVIS
University Extension

"This is the time of year to begin proper management to reduce grass tetany incidence in your cattle operation," says MU Extension Regional Livestock Field Specialist Patrick Davis. Grass tetany is related to mineral imbalances in cattle and if not prevented can lead to sickness and death. Therefore, Davis will discuss management strategies to reduce grass tetany incidence in your cattle operation.

"Spring lush forage growth leading to animal mineral imbalances results in grass tetany in cattle," says Davis. Spring forage has potential to be high in potassium and low in sodium which are important for absorption and utilization of magnesium by the animal. Magnesium is the most often indicated mineral deficiency in grass tetany but recent evidence suggests deficiencies in sodium are implicated in grass tetany as well. Therefore, Davis urges cattle producers to provide proper salt and magnesium supplementation free choice to reduce the incidence of grass tetany in cattle.

"Avoid grazing new grass till it reached 4 to 6 inches tall to reduce the incidence of grass tetany in your cattle herd," says Davis. Immature plants that are below this height have magnesium that is less available to the animal. Therefore, Davis urges cattle producers to graze new g ass at proper height for proper magnesium consumption to help reduce the incidence of grass tetany.

"Planting legumes and maintaining adequate pasture fertility can help reduce the incidence of grass tetany in your cattle herd," says Davis. Legumes are high in magnesium compared to grasses, and through cattle consumption should help reduce the incidence of grass tetany. Grass tetany is more likely in cattle grazing pastures over fertilized with nitrogen and potassium since these reduce the plants magnesium availability to the animal. Davis urges cattle producers to test and properly apply nitrogen and potassium fertilizers to reduce the incidence of grass tetany.

"Older early lactation cows are the most susceptible to grass tetany," says Davis. Early lactation cows are releasing large amount of magnesium in milk during lactation. This combined with older cow's reduced ability to mobilize bone magnesium leads to low serum magnesium levels and subsequent development of grass tetany. Davis urges cattle producers to reduce the incidence of grass tetany by grazing less susceptible animals like dry cows, heifers, stocker cattle and cows nursing calves more than 4 months old on high risk lush green pastures.

"Consult your veterinarian to plan treatment in case your cattle exhibit signs of grass tetany," says Davis. Grass tetany symptoms include unusual behavior, muscle tremors, frequent urination, staggers, and convulsions. Davis urges cattle producers to visit with their veterinarian and plan treatment protocols in case cattle exhibit these symptoms because swift action may lead to saving the animal.

"Cattle operation losses due to grass tetany can negatively impact productivity and profitably of the operation," says Davis. For more information on how to reduce the incidence of grass tetany in your cattle operation please contact your local MU Extension Livestock Field Specialist.

Local cattle company's bulls recognized in Ring of Gold Gelbvieh Championship

LINCOLN, NEB. – Throughout the 2021-2022 show year, Gelbvieh and Balancer® females and bulls competed at shows across the country to earn points for the American Gelbvieh Association (AGA) Ring of Gold program.

Each year, the qualifying animals are ranked at the conclusion of the National Gelbvieh and Balancer Show held in January. This year, a total of four shows were included in the Ring of Gold tally.

The AGA established the Ring of Gold program to honor the top animals shown at the conclusion of the show year. Points are earned for grand and reserve grand champions, as well as division champions and reserves, and are based on the actual number of animals shown at each show per division.

To honor those animals who have risen to the top during the show season, the Ring of Gold awards are presented to the top Gelbvieh female, Gelbvieh bull, Balancer

See **Ring of Gold**, Page 11B

CAMERON NOWACK with Sundance at Cattlemans Congress Jan. 2022 in Oklahoma City.

Ring of Gold • *from page 10B*

female and Balancer bull based on points awarded throughout the year. Animals must earn points in at least two shows to qualify for Ring of Gold points each year. The 2021-2022 Ring of Gold qualified shows were: Iowa State Fair, Missouri State Fair, American Royal and the Cattlemen's Congress.

To qualify for recognition, animals must have earned points in at least two Ring of Gold shows throughout the calendar year. Junior shows are not calculated into the total number of entries for the Ring of Gold tabulations.

This year, Nowack Cattle Company of Owensville, in partnership with Carroll Land & Cattle of Raymore, Mo., was awarded the first and second place Gelbvieh bulls in the Ring of Gold.

Taking first place was CRLL JNCC Empire 0983H ET. Second place was JNCC CRLL Sundance Kid 0242H.

Empire was also named Grand champion Gelbvieh bull at the 2002 National Gelbvieh and Balancer® Show, held on Jan. 4 at the Cattlemen's Congress in Oklahoma City.

Sired by JDPD Astro 407S and born Dec. 2, 2020, Empire first earned the title of champion senior bull calf.

The American Gelbvieh Association is a progressive beef cattle breed association representing 1,100 members and approximately 40,000 cows assessed annually in a performance-oriented total herd reporting system.

JARED NOWACK hold the reigns of his Grand Champion Bull, Empire at the American Gelbvieh Association 2022 Cattlemen's Congress national show. Also pictured, from left, are Greg Brandt, Maya Carroll, Jacie Carroll, Levi Perry, Brooke Nowack, judge Bruce Stertzbach, Caisie Nowack, Cameron Nowack and Sarah Carroll.

Did you know?

Agricultural technology, often referred to as "AgTech," is playing an increasingly bigger role on modern farms, and that role is evident when examining AgTech startups' growing access to venture capital. Data from PitchBook and the National Venture Capital Association's PitchBook-NVCA Venture Monitor, a quarterly report on venture capital activity in the entrepreneurial ecosystem, indicates that AgTech startups received $6.1 billion in VC investments in 2020. That reflects a nearly 60 percent increase in investment over 2019. Weaknesses in the agricultural and food supply chain revealed during the pandemic undoubtedly drove some of that investment. Widespread recognition of a need for improvements within the agricultural sector so it can meet the demands of a global population that the United Nations estimates will increase by two billion people by 2050 also likely contributed to the considerable rise in VC investment in AgTech startups.

Did you know?

Farmers and growers face a significant threat in the years to come as industrial agriculture operations continue to expand. According to the National Resources Defense Council, industrial agriculture is the large-scale, intensive production of crops and animals. Such operations make it more difficult for small farmers and growers to turn a profit, and they often involve the use of chemical fertilizers and pesticides. The use of such products poses an additional threat to small farmers and growers, as the Union of Concerned Scientists notes that the heavy application of fertilizers and pesticides accelerates soil erosion and increases pest problems. Consumers concerned by the effects of industrial agriculture on the environment and on small farmers' and growers' ability to earn a good living can support efforts such as regenerative farming and organic farms.

Without pollinators, more than 100 crops grown in the United States would not be able to thrive. Plants, including various fruits, vegetables, nuts and more, rely on pollinators to ensure to transport pollen. Though many plants are self-pollinating and others are pollinated by the wind or water, many others rely on insects and animals to become pollinated. The U.S. Department of Agriculture says birds, bees, bats, butterflies, moths, flies, beetles, and small mammals all can work as pollinators. Examples of crops pollinated by pollinators include apples, squash and almonds. Animals and insects help pollinate more than 75 percent of the world's flowering plants, and nearly 75 percent of all crops, according to the U.S. Fish & Wildlife Service. Unfortunately, pesticide use can diminish the number of natural pollinators. Natural gardening and pest-control can help protect the habitats of pollinators.

Legumes improve pastures, grazing, profits

BY PATRICK DAVIS
University Extension

Add legumes to grazing pastures to improve cattle performance and forage production, says University of Missouri Extension Regional Livestock Field Specialist Patrick Davis.

Frost-seed clovers and lespedeza now. They grow well with cool season grasses in Missouri and improve spring and summer pastures.

"Proper establishment is important to incorporation and persistence of these legumes," says Davis. He urges producers to work with their local MU Extension agronomist when seeding legumes. MU Extension guide sheet G4652 extension.missouri.edu/p/g4652also offers guidelines.

Clovers and lespedeza can be seeded by drill or broadcast, says Davis. He prefers drilling because it improves seed-to-soil contact for better establishment.

"If you broadcast seed, use cattle hoof action as well as the freezing and thawing process to work the seed into the soil," says Davis.

"Legumes improve year-round cattle grazing opportunities when added to cool season grass pastures," says Davis. Clovers enhance grazing in the spring while lespedeza improves grazing during late spring and summer.

Proper grazing management of legumes improves persistence and cattle performance, says Davis. He recommends rotational grazing to prevent overgrazing.

The proper grazing height and rest period help to maintain white clover in cool season pastures, says Davis. Graze pastures to 4-inch stubble height and then rest pastures three to four weeks to maintain mixtures of white clover, fescue, and orchardgrass.

"The best time to graze red clover is when about half the plants are blooming," says Davis. "At this point, the forage will yield a feeding value similar to alfalfa."

Cattle bloat is a concern when grazing high-protein, highly digestible legumes. Incorporate white clover in a mixed grass stand or slowly adapt cattle to very thick stands of clover to reduce bloat. Another way to reduce cattle bloat is to provide supplemental proxalene or bloat blocks to cattle, says Davis.

Lespedeza is a non-bloating legume that improves grazing in summer months, says Davis. Lespedeza is a drought-tolerant, warm season legume that provides summer grazing in cool season mixed pastures.

Do not overfertilize pastures with lespedeza, says Davis. Most fertilizer applications containing more than 30 pounds of nitrogen per acre will reduce stands of lespedeza. Lespedeza is an annual but will come back each year if it reseeds.

Clovers and lespedeza also help to reduce fescue toxicosis in cattle by diluting fescue pastures, says Davis. Adding legumes results in better quality forages, improved cattle production and higher profits.

To learn more about fescue toxicosis in cattle, see "Tall Fescue Toxicosis" at https://extension.missouri.edu/publications/g4669.

For more information, contact your local MU Extension agronomy or livestock field specialist. Find more resources on improving grasslands at https://extension.missouri.edu/programs/nrcs-mu-grasslands-project.

With high fertilizer prices, are you better off buying fertilizer or supplemental hay?

HAY IS wind-rowed June 17 off of Route V south of Owensville during the 2021 season. Area farmers are already making decisions on what their fertilizer options are for the 2022 season due to higher costs for supplies.

PHOTO BY DAVE MARNER

BY LINDA GEIST
University Extension

COLUMBIA — Increases in fertilizer prices add to the cost of growing forage for grazing. This leads farmers to ask if they should buy hay or fertilizer, says University of Missouri Extension nutrient management specialist John Lory.

Comparing the benefits of buying hay vs. applying fertilizer for better yields is complicated, but it is crucial to the bottom line, says Lory.

A fair comparison looks at the costs of hay vs. fertilizer, whether the farmer can use the grown forage or purchased hay, and the nutrient efficiency of the grown forage vs. purchased feed.

Studies at the MU Forage Systems Research Center in Linneus and MU Southwest Research Center in Mount Vernon give some insight, he says.

MU researchers found that 50 pounds per acre of nitrogen boosted spring pasture yield an average of 1,100 pounds

See **High prices**, Page 15B

High prices • *from page 14B*

per acre. With nitrogen fertilizer prices near $1 per pound, the cost of that feed is 5 cents per pound.

What is the cost based on utilization rate?

Lory explains that cattle only eat part of the forage available to them, leaving the rest to waste. High prices make it critical to manage pastures for high forage utilization rates.

Research shows that cattle eat about 60 percent of available forage in highly efficient spring grazing systems, but rates typically dip below 50 percent. That means that cows waste about half of the fertilized forage. At 50 percent use, the actual cost of consumed forage doubles, says Lory. If nitrogen fertilizer is $1 per pound, cost of consumed feed is 10 cents per pound. Many farmers can buy hay for less that that now.

Forage use for purchased feed usually runs higher than that for grazing, says Lory. Hay utilization rates can reach 80 percent but most often are closer to 65 percent. If hay is $80 per ton, the cost per pound is 4 cents. However, at 65 percent utilization, the cost per pound of feed eaten goes to 6 cents.

"These examples show how purchased feed has the potential to be an economically competitive approach compared to buying fertilizer when prices are high," says Lory.

Hay: Feed and fertilizer

The fertilizer value of hay can offset cost.

"When you bring hay or other supplemental feed onto your farm, you are buying feed and fertilizer at the same time," says Lory. "A ton of fescue hay contains nearly 100 pounds of fertilizer nutrients. If spread strategically on your farm, these nutrients provide fertilizer value to offset the cost of the hay."

Beef cows typically excrete most of the nutrients they eat. To get the most value from hay, move the hay and cows to pastures that need fertilizer. Unroll hay bales, move hay rings or use some type of bale-graze system to spread across pastures. All of the excreted phosphate, potassium, sulfur and micronutrients in the hay is available to the pasture as fertilizer, but only about 25 percent of the nitrogen is available. The rest is lost or tied up in the soil organic matter. So, a ton of hay with 12.5 percent protein provides about 10 pounds of nitrogen fertilizer, 12 pounds of phosphate and 35 pounds of potash.

The fertilizer value of hay is usually a little over a penny per pound, or slightly more than $20 per ton. Recently, nitrogen prices rose to nearly $1 per pound, and phosphate and potash prices more than doubled. This increases the fertilizer value of hay to more than 2.5 cents per pound.

In pastures, nutrients brought onto the farms as feed or fertilizer recycle and improve yields. When winter feeding hay, the hay's fertilizer will increase spring pasture growth. When properly managed, about 5 tons of feed on a pasture with a total nitrogen fertilizer value of 50 pounds can provide an additional 1,000 pounds or more of quality spring forage growth.

Fertilizer value also can influence hay purchase decisions, says Lory. Buying high-quality hay increases the fertilizer value of the hay. With current costs, a ton of hay may have $20 more fertilizer value than poor-quality hay, making the higher-quality hay the more economical feed, even if it costs more up front.

Hay: Predictable feed at a known price with fertilizer value

"Buying hay instead of fertilizer can provide a predictable feed supply to supplement spring pasture growth at a known price," says Lory. "High utilization can be assured through judicious feeding practices, and unneeded hay can be stored if not used. With high prices, the fertilizer value of the hay has more than doubled, currently around 2 ½ cents per pound of forage or $50 per ton, offsetting a significant fraction of cost of hay. The fertilizer value of the hay also will boost spring forage growth."

No matter how you meet your herd forage needs, he adds, high prices require you to maximize forage utilization, both when feeding hay and managing pastures.

For more information, see the MU Extension publication "Calculating Fertilizer Value of Supplemental Feed for Cattle on Pasture." The four-page guide is available for free download at extension.missouri.edu/g2083.

THE 2021 hay harvest was pretty respectable according to local farmers out mowing, raking, and baling in early June. This field from the Tappmeyer Farm where it partially surrounds th

he City Cemetery annexation, was being baled in mid-June.

PHOTO BY DAVE MARNER

Weed electrocution research sparks interest as herbicide resistance impedes current methods

BY LINDA GEIST
University Extension

COLUMBIA — Move over, herbicides. There's a new sheriff in town. And he's toting some powerful guns loaded with electricity to kill weeds.

This shocking new method of weed control was demonstrated at the 2021 Pest Management Field Day at the University of Missouri Bradford Research Center in Columbia.

As more weeds develop resistance to herbicides, electrocution may be the weed management approach of the future, says MU Extension weed scientist Kevin Bradley. MU graduate student Haylee Schreier has studied weed electrocution in row crops for the past two years under Bradley's direction.

The is of special interest to Bradley because it might be the answer to Missouri's growing waterhemp problem. A prolific

See **Electrocution**, Page 19B

WEED ELECTROCUTION research shows promising results for weed management, especially in waterhemp, Missouri's No. 1 weed problem. The Weed Zapper attaches to a tractor and kills in-row weeds with high-voltage electricity.

PHOTO BY LINDA GEIST

Electrocution • *from page 18B*

producer of seeds, waterhemp is Missouri's No. 1 weed problem and one of 14 weeds that are herbicide-resistant.

Two brothers in Illinois with backgrounds in farming and engineering designed The Weed Zapper machine. A different pair of brothers purchased the technology and manufacture Weed Zappers at a plant in Sedalia, Missouri.

The Weed Zapper model used in MU research has a copper boom that attaches to the front of a tractor. Driven by a PTO, it hits weeds with 15,000 volts of electricity from a 110,000-watt generator on the back of the tractor. Models cost between $42,000 and $72,000.

Metal wheels are grounded, and booms adjust to different heights. Tractor speed is about 2-4 miles per hour, Bradley says. Weed kill is best at lower speeds and is even more effective on some of the more challenging weeds when used at seven-day intervals in late summer.

Schreier's data shows that by the end of the season there is almost complete control of giant ragweed, common ragweed, marestail and waterhemp. It is slightly less effective on grasses.

The growth stage of soybean and the degree of contact that the boom makes with the foliage influences soybean injury. Soybean yield loss is possible if the boom makes constant contact with the soybean canopy at growth stages R3 or later.

In addition to killing weeds, electrocution also affects viability of surviving weed seeds. The most impact is seen in waterhemp, where about 65 percent of seeds become nonviable.

Electrocution is not new to the weed management world, says Bradley. Sugar beet growers in North and South Dakota have been trying this method since the 1950s and 1960s.

The United Soybean Board, Missouri Soybean Merchandising Council and the Weed Zapper company are partners in this project.

Learn more about MU weed science research at weedscience.missouri.edu, on Facebookor @ShowMeWeedson Twitter.

Learn more about Weed Zappers at www.TheWeedZapper.com.

See Farming, Page

Treat time

Kyle Brandt of R.B. Brandt & Sons loads out a pallet of fish food pellets for a customer in April 2021. The family-owned feed store located in Owensville custom grinds livestock feed and stocks items such as the fish pellets for use in local ponds and lakes by sport fishermen.

PHOTOS BY DAVE MARNER

MU Extension agronomist offers tips to offset high nitrogen prices

BY LINDA GEIST
University Extension

GALENA — If there was ever a time to do a soil test, this is it, says University of Missouri Extension agronomist Tim Schnakenberg.

Rising fertilizer prices make it too expensive to guess on how to apply nutrients, says Schnakenberg.

Soil tests can prevent buying and applying fertilizer where not needed. See the MU Extension publication "Soil Sampling Hayfields and Row Crops" at extension.missouri.edu/g9217.

Schnakenberg offers several other tips to offset high prices:

• When prices are high, producers might want to prioritize lime over fertilizer if the soil's pH is low. Lime application improves nutrient availability in the soil, which leads to more fertility from resources already waiting to be tapped

• Using manure from dairy or poultry operations might be a good way to add needed nutrients. Consider demand, trucking costs and the source of the litter.

• Reduce nitrogen loss by injecting manure and commercial sources into the ground instead of spreading on top of the ground.

• Use nitrogen stabilizers with commercial sources unless applied in cooler weather.

• Split applications sometimes can be a more efficient way to reduce losses. Check with your local extension agronomist for the most precise method of nitrogen applications on specific crops and forages.

Don't overlook ways to more efficiently distribute manure already generated on the farm, Schnakenberg says. If you feed grass hay solely in a bunk at the same location each time, move hay feeding areas around to distribute the manure to other parts of the farm. MU research has also confirmed that a well-planned rotational grazing system greatly helps manure distribution in pastures.

Legumes such as clover and alfalfa are also good long-term sources of nutrients. They fix nitrogen for grass hay crops. Incorporate these legumes into pastures to potentially eliminate the need for nitrogen. Legumes take time to reach their full potential, especially if broadcast over the winter or sowed in the spring.

If prices continue to rise, Schnakenberg recommends applying phosphate and potash in the fall or early winter. There is little to no loss, and there may even be benefits from early application because there is time to work nutrients into the upper soil profile where roots can fully access them when needed next year.

This recent price hike is a reminder to continuously monitor nutrient levels and maintain fertility as part of a management plan, says Schnakenberg. "It becomes economically unfeasible to fix problems that have developed over the last decade, leaving us suffering production losses that aren't easily remedied."

In any case, don't get into the mindset of only applying nitrogen, he says. Many fields continue to show stress resulting from missed or reduced applications of phosphate and potash after the 2008 fertilizer price hike.

The plant structure of roots, stems and leaves must be built by nutrients like phosphorus and potassium before nitrogen can spur growth, Schnakenberg says. If large amounts are needed and you have to cut corners somewhere, consider at least addressing crop nutrient removal issues and forgoing build-up recommendations. Consult an agronomist for advice on this kind of management strategy.

Things to consider when selecting crop insurance

BY BEN BROWN
MU Extension

Farmers must finalize their crop insurance decisions for spring planted crops in Missouri by March 15. In 2021, over 9 million row crop planted acres in Missouri were covered by crop insurance policies overseen by the USDA Risk Management Agency. Most farmers purchase revenue protection insurance policies, followed by yield protection policies. Opportunities to increase risk protection within these crop insurance policies are presented below.

Prevent Plant Coverage

Crop insurance's prevented planting provisions provide protection to producers and landowners if they are prevented by extreme weather from planting the insured crop by the insurance policy final planting date or during the late planting period. Prevented planting payments are intended to cover costs accrued prior to planting.

Prevented planting coverage is part of revenue protection and yield protection plans but not of area-based plans. Coverage is calculated as a percent of the policy's insurance guarantee. Coverage factors for corn are 55 percent and 60 percent for soybeans, wheat, and grain sorghum. Example: a farmer buys a 75 percent revenue protection policy on corn acres with $800 of expected revenue. Should the farmer be prevented from planting the crop, a prevented planting payment of $330 ($800 x .75 x .55 = $330) would be paid. For an additional premium cost, prevented planting coverage can be increased to 60 percent for corn and 65 percent for soybeans, wheat, and grain sorghum.

When considering the 5 percent prevented planting buy-up coverage, estimate pre-planting costs like land rent, fall fertilizer application, and herbicide burndown. If the default prevented planting coverage does not cover pre-planting costs, a risk adverse farmer might be enticed to purchase the 5 percent buy-up option.

High Coverage Policies

The 2014 Farm Bill introduced Supplemental Coverage Option (SCO). At its core, SCO adds additional area-based coverage above the underlying policy up to 86 percent, with certain restrictions. Example: an underlying Revenue Protection (RP) policy of 70 percent could buy a 16 percent band (86 percent – 70 percent) of SCO revenue protection. The policy holder would have individual revenue protection below 70 percent, area revenue coverage between 70 – 86 percent and no revenue protection between 86 percent and 100 percent.

Congress added an additional high coverage option in the 2018 Farm Bill titled Enhanced Coverage Option (ECO) allowing farmers and landowners to add a layer of area level insurance either between 86 percent – 95 percent or 90 percent – 95 percent. Producers using ECO are allowed to enroll in ARC.

Some key points to consider about SCO and ECO are:

High coverage policies provide more protection for an operation by triggering at more shallow losses but come at a higher premium cost.

Government subsidies for SCO premiums are 65 percent; 51 percent for ECO yield policies; and 44 percent for ECO revenue policies.

SCO and ECO are both area-based coverage policies. It is possible for both to trigger payments for losses, only one, or neither.

SCO and ECO cannot be elected if the underlying crop insurance policy is margin protection, area based, or stacked income protection plan.

ECO can be purchased with or without SCO.

SCO and ECO do not qualify for prevented plant coverage.

Conclusion

All crop insurance premiums are set by the USDA Risk Management Agency – not the insurance company selling the policies. This means that the difference between crop insurance providers is the help they can give you at signup and throughout production until the crop is harvested and any indemnities are paid. Ask your crop insurance agent to help you analyze the risk management impacts of the +5 percent prevent plant provision, and the SCO and ECO high coverage policies.

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Cereal rye as a cover crop can reduce waterhemp

BY LINDA GEIST
University Extension

COLUMBIA — Cereal rye as a cover crop may reduce waterhemp populations without yield loss in soybean, according to a three-year study at the University of Missouri.

MU Extension weed specialist Mandy Bish and a team of researchers studied how planting soybean into living cereal rye—"planting green"—and then terminating the cereal rye affected biomass accumulation, soybean stand and yield, and early-season waterhemp emergence. The Missouri Soybean Merchandising Council funded the experiment.

High seeding rates do not increase biomass

The team seeded cereal rye at 30, 50, 70, 90 and 110 pounds per acre in late October and early November. At soybean planting, cereal rye ranged 40-43 inches. Bish found that higher seeding rates of cereal rye did not increase biomass. Regardless of seeding rates, biomass generated was about 14,500 pounds per acre.

Biomass does not affect yield or stand

Bish says accumulated biomass did not affect soybean stand compared to soybean planted into no cover. However, soybean planted into cereal rye grew taller than soybean planted into no-cover plots. Soybean yield was about the same, regardless of seeding rate.

Waterhemp reduced in 2 of 3 years

Biomass from cereal rye cover crop reduced waterhemp emergence for four weeks in 2018 experiments and six weeks in 2020 compared to plots without a cover crop. But this was not true in 2019, when waterhemp pressure at the study site was extremely high.

Bish says residual herbicides were not applied in this study, but the group continues to research integration of cereal rye cover crop with residual herbicides. In a USDA-funded study, MU's results show that early-season weed emergence was suppressed by about 97 percent when cereal rye was terminated before stem elongation was complete (about two weeks before soybean planting) and a residual herbicide was applied at soybean planting.

"We are currently evaluating combinations of soybean planting dates, cereal rye termination timings and residual herbicide applications in a collaborative project funded by the United Soybean Board," Bish says.

No silver bullets in weed control

"Cereal rye, nor any cover crop, should be viewed as a silver bullet for weed control," Bish says. Understanding the soil seed bank is extremely important when making decisions about integrating cover crops and chemicals for weed control, she adds.

"In studies where waterhemp seed in the soil seed bank was extremely high (corresponding to roughly 500 or more plants per square meter), we have not seen cereal rye consistently suppress waterhemp from emerging," Bish says. "However, when waterhemp densities are around 100 to 200 plants per square meter, we can see the effects of cereal rye on waterhemp suppression."

For more information

• "To terminate or not to terminate? What we've learned about cereal rye, planting green, and seeding rates," MU

See **Cereal Rye**, Page 25B

DURING A RECENT FIELD DAY, MU Extension weed specialist Mandy Bish explains how using cereal rye as a cover crop may reduce waterhemp without yield loss in soybean.
PHOTO BY LINDA GEIST

Cereal Rye • *from page 24B*

Integrated Pest & Crop Management newsletter, March 2021: ipm.missouri.edu/IPCM/2021/3/cerealRye-MB.

• In "Cover Crops for Weed Management," part of the War Against Weeds podcast series (waragainstweeds.libsyn.com), Bish discusses cover crops and weed management with MU Extension state weed specialist Kevin Bradley.

New MU guide looks at silage breakeven price

BY LINDA GEIST
MU Extension

COLUMBIA — University of Missouri Extension recently released an updated cost analyzer to help farmers estimate the breakeven price to justify harvesting corn as silage rather than grain.

"Frequently, corn harvested for silage was planted for harvest as a grain crop," says Joe Horner, an MU Extension agricultural business and policy specialist. Reasons for this change can include feed needs as well as drought and other events that result in poor grain yield.

Horner and MU Extension economist Ray Massey created the guide to help producers take the guesswork out of the decision to harvest corn as a grain or silage. Silage is the harvest of whole corn plants at 60–70 percent whole plant moisture.

The guide gives options for pricing silage in the field, delivered to storage and delivered to the feed bunk.

Nutrient considerations

Silage and other forage crops remove more nutrients — especially phosphorus and potassium — from the soil than grain cops. If the soil becomes low on nutrients, the producer incurs extra expense to replace them.

Planting corn for silage to deliberately remove nutrients also is an option in intensive manure-spreading areas and where the potential for nutrient runoff exists.

General rules of thumb

Generally, the rule of thumb farmers use is that silage's value per ton is 8–10 times the price of a bushel of corn. Massey says a factor of 8–9 is used to price silage in the field and a factor of 9–10 for pricing it in storage.

A higher factor is generally used for lower-priced corn and a lower factor for higher-priced corn. "This rule of thumb needs to be reconsidered given current corn and input prices," says Massey. "Currently, silage priced in the field may be closer to seven times the price of a bushel of corn."

Another consideration is the dry matter percentage of silage. Most often, price is determined on wet basis — as it stands in the field.

See **Silage**, Page 29B

Planning budgets from MU Extension can help manage high farm operating costs

BY KYLIE JOHNSON
MU Extension

COLUMBIA — Farms will pay significantly more for operating expenses this year. 2022 planning budgets from the University of Missouri can help livestock, row crop and forage operations quantify how much costs have increased and determine what those higher costs mean for the bottom line.

For crops, fertilizer represents one cost that has sharply increased in recent months, says Ryan Milhollin, extension agricultural economist.

"Fertilizer prices have gone through the roof since October," Milhollin said. "I don't think anybody would have predicted fertilizer prices doing what they did."

Ben Brown, senior research associate at MU, says fertilizer costs and other variable expenses, such as labor, fuel and chemicals, have increased due to supply chain disruptions and market conditions. Fixed costs, such as those for land and machinery, have also risen based on expected returns in 2022 and increases in the money supply.

Livestock producers can expect higher costs for inputs such as protein supplements, grain, salt and minerals and labor.

Each 2022 planning budget estimates the total economic costs involved in an enterprise. Those costs include cash expenses and opportunity costs, such as those for owned land and your time.

You can tailor each budget to fit your farm and understand your cost structure for each farm enterprise. With this information, you can then determine how to best control input costs, set price targets for the year or size up and down farm enterprises to maximize profits.

"We really want to empower and encourage farmers, lenders and other people who use these budgets to customize them for their situation and when they need to make a decision," Milhollin said.

MU Extension enterprise planning budgets and spreadsheets for customizing budget assumptions are available for free download at muext.us/MissouriAgBudgets.

Plan now for antibiotic changes on the horizon

In 2023, antibiotics that are currently available over the counter will require a veterinarian's prescription.

BY LINDA GEIST
University Extension

COLUMBIA, Mo. – While 2023 might seem a long way off, it's not too early for livestock producers think about how recent Food and Drug Administration guidance might affect their operations, says University of Missouri Extension veterinarian Craig Payne.

On June 11, the FDA's Center for Veterinary Medicine published Guidance for Industry No. 263 (GFI #263) in the Federal Register. The document outlines a strategy and timeline for bringing all medically important antibiotics that are currently available over the counter under veterinary oversight. This will affect several antibiotics familiar to livestock producers.

If you have a valid veterinarian-client-patient relationship (VCPR), the impact will be minimal because a veterinarian will be able to issue a prescription for these antibiotics, says Payne. If you don't have a VCPR, now is the time to find a veterinarian willing to work with you to ensure future access to antibiotics.

Under a VCPR, a veterinarian must have sufficient knowledge of your operation to make medical judgments, he says. It also means you agree to follow the veterinarian's instructions.

In 2017, many antibiotics used in the feed or drinking water of livestock moved from over-the-counter status to requiring a Veterinary Feed Directive or prescription. However, a small percentage remained available OTC in other forms, such as injectables, intramammary tubes and boluses, Payne says.

GFI #263 specifically addresses this small percentage. The FDA expects the labels of these remaining OTC antibiotics to display the following language by June 11, 2023: "Caution: federal law restricts this drug to use by or on the order of a licensed veterinarian."

"This will end over-the-counter sales of antibiotics, and livestock owners will need a prescription from a veterinarian in the future if they want access to antibiotics," Payne says.

He emphasizes that antibiotics won't necessarily have to be purchased through a veterinarian, but a prescription will be required.

GFI #263 is available at www.fda.gov/media/130610/download.

Examples of affected products:

Cephapirin, cephapirin benzathine
- Intramammary tubes: ToDAY and ToMORROW

Gentamicin
- Injectables: Garasol, Gentamicin Piglet Injection

Lincomycin
- Injectables: Lincomix 100, Lincomix 300, LincoMed 100, LincoMed 300

Oxytetracycline
- Injectables: Liquamycin LA-200, Noromycin 300 LA, Bio-Mycin 200, Agrimycin 200, etc.
- Boluses: Terramycin Scours Tablets, OXY 500 Calf Boluses

Penicillin G procaine, penicillin G benzathine
- Injectables: Penicillin Injectable, Dura-Pen, Pro-Pen-G, Combi-Pen 48, etc.
- Intramammary tubes: Masti-Clear, Go-dry, Albadry Plus

Sulfadimethoxine, sulfamethazine
- Injectables: Di-Methox 40 percent, SulfMed 40 percent
- Boluses: Albon, Sustain III Cattle & Calf Boluses, Supra Sulfa III Cattle & Calf Boluses

Tylosin
- Injectables: Tylan 50, Tylan 200

Young Farmers Attend Farm Bureau YR&R Leadership Conference

JEFFERSON CITY — The Missouri Farm Bureau (MOFB) Young Farmers and Ranchers (YD&R) Leadership Conference was back at the Lake of the Ozarks Margaritaville Resort after a one-year hiatus. Considered one of the largest state YF&R conferences in the country, the Feb. 12–14, event attracted close to 600 people. Those attending from Gasconade County enjoyed a weekend away from farm chores to catch up with their peers and the latest industry news.

MOFB's YF&R Committee organizes the conference for farmers ages 18 to 35. The 2020 and 2021 committee combined to plan this year's conference.

MOFB president and Appleton City farmer Garrett Hawkins opened the conference, touching on the theme United We Stand. "Missouri is a special place in agriculture," he said. "Our industry is diverse, our state is the bridge between southern and midwestern agriculture. The Kansas City region is is the global hub for animal health innovation, while the St. Louis region has more plant science PhD's than any other area in the world." It all starts with our Missouri farmers and ranchers. "Farm Bureau represents the diversity of agricultural production and our members' operations come in all sizes… We know that to bring our kinds back home to the farm, we have to ensure our communities are thriving. Our policies defend and support that."

Breakout sessions gave young farmers a chance to share who they are with fellow farmers. Topics covered how geopolitical and regulatory pressure affect input cost, farm markets, drone use, soil testing and keeping livestock healthy. Fifteen different sessions had something for everyone, including whine and beer tasting.

Five young farmers competed in the MOFG YF&R Discusson Meet during the conference. After two rounds, judges named Cameron Locke of Cedar County winner. Second place wend to Travis Ellis of DeKalb County. Locke won $500 awards from Ford Motor Company and the MOFB Foundation for Agriculture. He will compete for the national prize of a new Ford pickup at the AFBF annual meeting in Puerto Rico this January.

Walk. Ride. Rodeo. Those three words were put into perspective by keynote speaker Amberly Snyder. The champion horse-riding barrel racer overcame physical challenges after an auto accident to continue her passion for horses. She shared her story of going from walking and riding horses to learning how to become a champion in the saddle again after being paralyzed from the waist down.

New chair of the MOFB YF&R Committee, Bryant Kagay of Maysville, closed out the meeting. He thanked MOFB Insurance Companies for their sponsorship. More than 60 companies and individuals lend their support to the conference.

THOSE ATTENDING the YF&R Leadership Conference from Gasconade County included: Charlotte Rohlfing, Kevin Rohlfing, Everett Meyer, Cody Meyer, Trina Meyer, Amy Estes, Laura Hardecke, John Estes and Hannah Estes (not pictured).

Silage • *from page 26B*

Other considerations

Producers should also consider costs of harvest, shrink, drying, transport and storage. Livestock producers should weigh costs against the cost of other feedstuffs.

Silage harvest requires specialized equipment, including a chopper and wagons.

Also, consider the removal of biomass for silage. The standing crop's value increases because only the grain is removed rather than the entire plant.

See "Pricing Corn Silage" and the silage cost analyzer spreadsheet at extension.missouri.edu/g4591.

Missouri freezing temperature trends

PATRICK GUINAN
University Extension

Missouri air temperatures are trending warmer over the last couple of decades, which is extending the growing season. Figures 1 and 2 show the statewide averages for spring and autumn minimum air temperatures, respectively, over the last 127 years. The trend line indicates a warming of 1.4°F per century. Autumn air temperatures have trended 0.8°F higher.

Dates of last or earliest frost have also shifted. It seems good to focus in on those shifts as we approach the 2022 planting season. Here are 3 findings on Missouri freezing temperatures that stem from comparisons of 20-year averages to 127-year averages:

The last spring freeze is occurring earlier. Figure 3 shows that the average last spring freeze is occurring 3 to 6 days earlier than historical trends.

The first autumn freeze is occurring later. Figure 4 shows that the average earliest autumn freeze is occurring almost one week later than historical trends.

The average increase in growing season days across Missouri ranged from 7 days (Barton County site) to 20 days (Lewis County site).

These are anticipated trends in a warming world, but Missouri weather is still variable and seemingly random freeze events can and will occur late in spring or earlier in the fall.

The 11 weather stations used in this analysis have a long, reliable track record. They are part of a network called the National Weather Service Cooperative Observer Program, which was established in 1890 when President Benjamin Harrison signed the Organic Act. A major premise of the program was to define the United States climate.

For more information on frost and freeze dates in Missouri, please check out the MU Frost Freeze Guide, which receives a lot of interest this time of year. The web site includes contour maps that show variations in frost/freeze temperature patterns across Missouri. Extreme dates maps are also included. These maps show the most extreme frost/freeze dates in spring and autumn at 25 weather stations across Missouri.

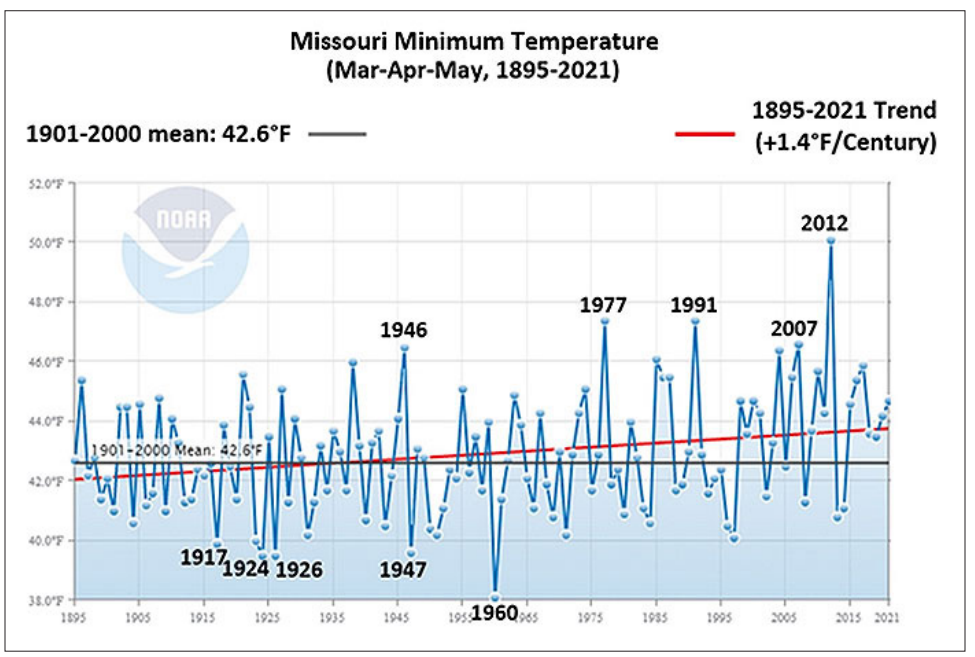

FIGURE 1 Statewide, the average minimum air temperatures in the spring are increasing.

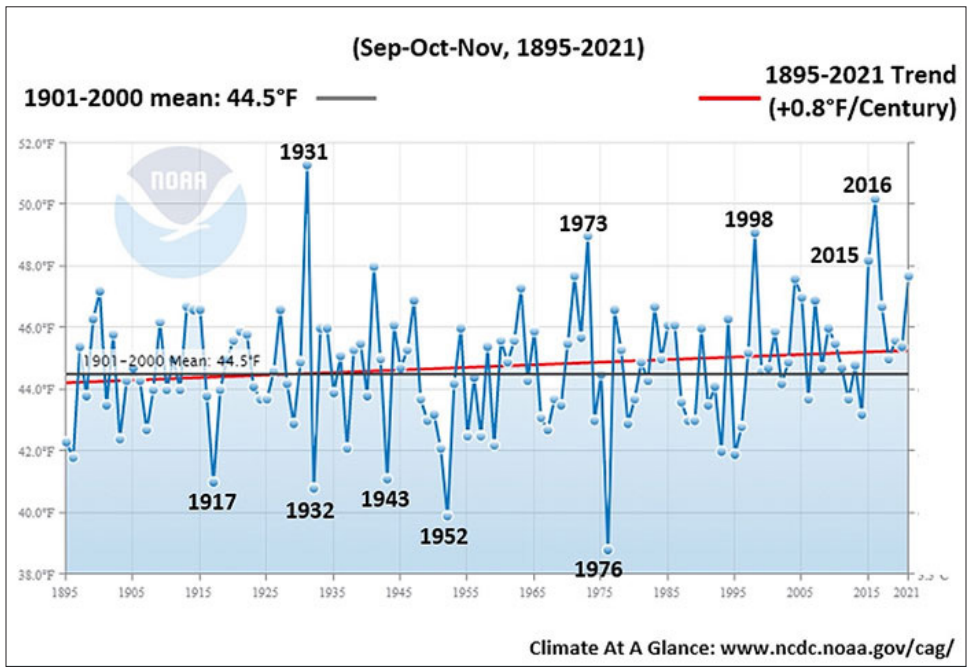

FIGURE 2 Statewide, the average minimum air temperatures in the autumn are rising.

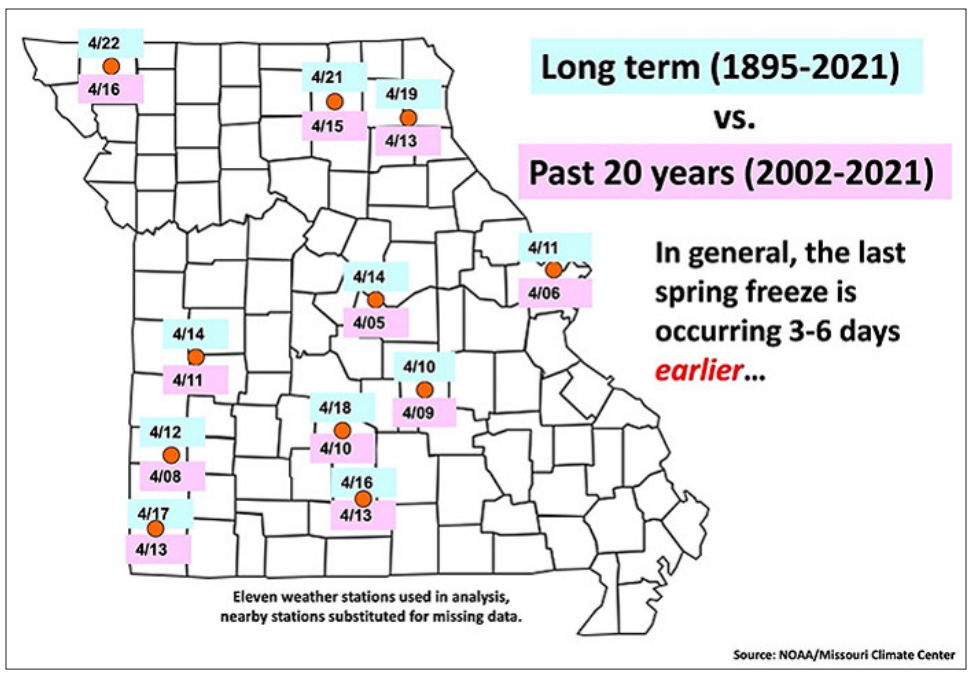

FIGURE 3 Median Date of Last Spring Freeze (≤ 32 Fahrenheit).

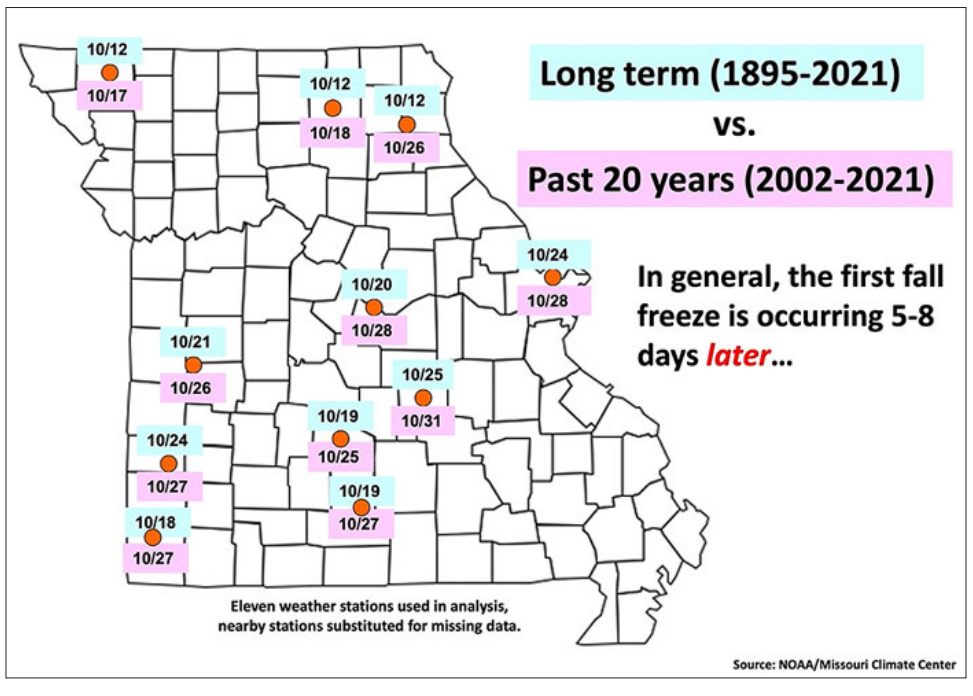

FIGURE 4 Median Date of First Fall Freeze (≤ 32 Fahrenheit).

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