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## **Carbon Coating Gives Biochar Its Greening Power**

By Anne Manning, CSU

For more than 100 years, biochar, a carbon-rich, charcoal-like substance made from oxygen-deprived plant or other organic matter, has both delighted and puzzled scientists. As a soil additive, biochar can store carbon and thus reduce greenhouse gas emissions, and it can slow-release nutrients to act as a non-toxic fertilizer.

But the precise chemistry by which biochar stores nutrients and promotes plant growth has remained a mystery, so its commercial potential has been severely limited.

Now, an international team of researchers, with key contributions by Colorado State University experts, has illuminated unprecedented detail and mechanistic understanding of biochar's seemingly miraculous properties.

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## Biochar continued from page 1

The [Nature Communications study](#), led by Germany's University of Tuebingen and published Oct. 20, demonstrated how composting of biochar creates a very thin organic coating that significantly improves the biochar's fertilizing capabilities. A combination of advanced analytical techniques confirmed that the coating strengthens the biochar's interactions with water and its ability to store soil nitrates and other nutrients.

This improved understanding of biochar's properties could trigger more widespread commercialization of biochar fertilizers. Such a change could reduce global dependence on inorganic nitrogen fertilizers that have served as modern food-production workhorses for more than a century.

### CSU contribution

The international collaboration included CSU's Thomas Borch, professor in the Department of Soil and Crop Sciences with joint appointments in chemistry and civil and environmental engineering,

and research scientist Robert Young. The CSU team contributed high-resolution mass spectrometry performed at Florida State University's National High Magnetic Field Laboratory. Their data helped to confirm the composition of the biochar's nanoscale carbon coating.

"To characterize a super-thin carbon coating on a carbon substrate is nearly impossible," Borch said. "Our international team used many different advanced techniques to perform the analyses. Robert Young led our group's contribution of ultra-high resolution mass spectrometry to investigate the coating and probe its elemental makeup."

### Composted biochar

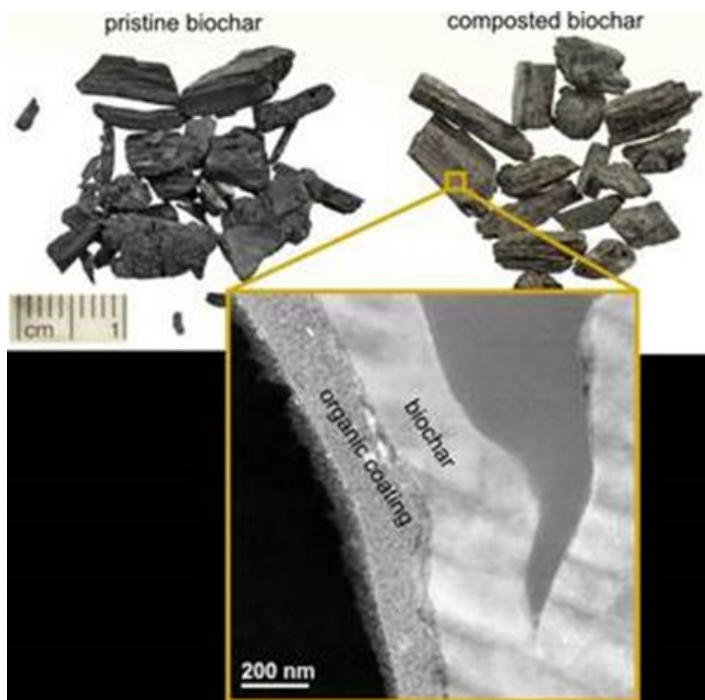
The study was led by Andreas Kappler, of the Center for Applied Geoscience at the University of Tuebingen, and geo-ecologist Nikolas Hagemann. The authors set out to investigate biochar before and after composting with mixed manure. Using a combination of microscopic and spectroscopic analyses, the researchers found that dissolved organic substances played a key role in the composting of biochar and created the thin organic coating.

"This organic coating makes the difference between fresh and composted biochar," Kappler said. "The coating improves the biochar's properties of storing nutrients and forming further organic soil substances." Hagemann added that the coating also developed when untreated biochar was introduced into the soil – only much more slowly. Composting experiments were carried out on a small commercial scale using infrastructure and expertise of the Ithaka Institute in Switzerland.

### Why biochar?

Excessive use of mineral nitrogen fertilizers or liquid manure in agriculture has serious impacts on the environment. Such fertilizers cause the emission of nitrous oxide and result in nitrates leaching into the groundwater. As an eco-friendly alternative, scientists have suggested adding biochar as a nutrient carrier into the soil. But use of biochar on a

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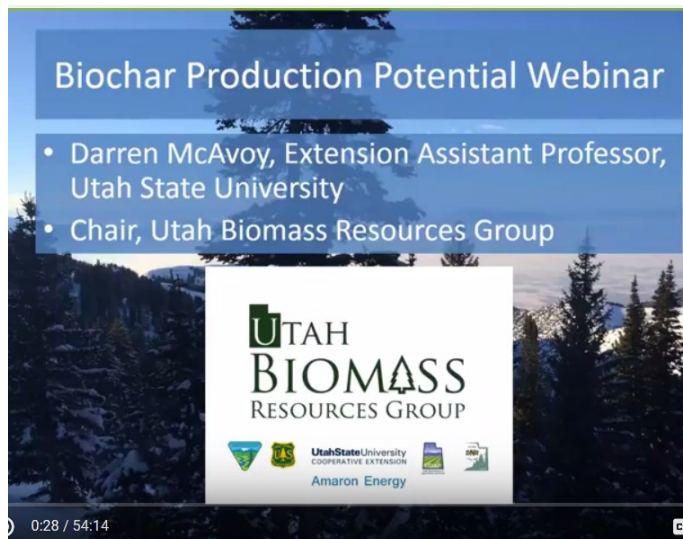
**Illustration: Mihaela Albu, Austrian Cooperative Research, Graz; Wolfgang Gerber/Nikolas Hagemann, University of Tübingen**

## Biochar continued from page 2

large scale has not been economically viable because so little was known about exactly how it stores and releases nitrates.

“In agricultural crop production, higher yields usually only occur when biochar is applied together with nutrients from non-charred biomass such as liquid manure,” Hagemann said. “Using biochar without adding nutrients or with pure mineral nutrients has proved to be far less successful in many experiments.”

The research was supported by the Rosa Luxemburg Foundation (Berlin) in the form of a doctorate scholarship for Nikolas Hagemann, the EU COST Initiative TD1104 and the Ithaka Institute (Switzerland).



Watch [Biochar Production Potential webinar](#) to learn more about biochar.



## An Apple A Day

By Bruce Borrman, The North Weld Herald Newspaper

In February 1951, a hard freeze claimed many of the fruit orchards along the Front Range, where the weather is generally optimal for growing apples, apricots, plums and cherries. “At that time, Colorado was producing more apples than its competitor, Washington state,” said Will Sander, who co-owns a one-acre apple orchard with his wife, Lori, kittycorner from the Eaton Elementary School. “Following that hard freeze, many orchard owners moved their operations from the Front Range to the Grand Junction area and started over,” explained Greg Worrell, who, along with his wife Melanie, own and operate Worrell Farms. The Worrells started their 7.5-acre apple orchard four years ago when they planted their first 600 trees. They planted another 500 trees a year later.

The Worrells took what was once considered a dry and unproductive piece of land three miles east of Eaton, added drip irrigation, and made it flourish with fruit trees: 80% apples (23 varieties), 19% pears (six varieties), and 1% peaches.

Greg was born and raised in the Cherry Creek Dam area (Aurora), and Melanie was raised on a cattle ranch in Oklahoma. The Worrells moved to Greeley in 1988. Melanie wanted to eventually return to a rural setting. They found this property. It was perfect for what they wanted to do. “It had water,” explained Greg. “Agricultural land is available everywhere, but having water is most important when looking for a place to grow crops.”

The Worrell’s farm not only produces fruit, but also low lignin alfalfa they sell to local dairies and some horse owners. A three-season quonset-style hoop house prolongs their garden growing season, and their raspberry patch is very prolific.

Greg says there are downfalls to growing fruit trees, or any crop for that matter. In November

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### Apples from page 3

2013, the temperature dipped from 55 degrees down to 30 below zero. "A third of our trees were wiped out, and half of the remaining trees were hurt." The Worrells replanted, and continued to produce some very tasty fruit. He added, "We are at the mercy of nature, and hopefully this is the rebirth of orchards along the front range."

Mr. Worrell is very knowledgeable and casually explains his tactics for growing tasty apples. He believes the use of pesticides and other treatments should be minimally used, and he gives his trees a deep drink once a week. Greg strolls throughout his orchard on a regular basis to observe how his trees are doing to stay ahead of any problems. In February or March they prune and shape their trees.

Most apple trees are two trees in one. One variety of roots is grafted with another variety of tree. Grafting allows the best of both worlds, making their trees both drought and pest resistant. He knows his apples are ripe when the birds tell him so. They start pecking at the ripe fruit. "We have to share with the birds," he laughs. However, an eight foot tall fence protects their orchard from deer.

He said there is a set of criteria when it comes to the commercial fruit industry: First is how does it store, then how does it travel, uniformity, and then taste." However, he believes "Taste should be number one."

The Worrells started tasting heirloom varieties not found in stores to determine which they wanted to grow. "We found the Liberty has a 'wow' factor. And Honey Crisp is another favorite. Our Sweet 16 is perfect for apple pies, cobblers, baking. These varieties are all now in season."

As far as grades of apples: A is for Awesome, sold in grocery stores; B is for Blemished, these are the ones sold to schools and cafeterias; C means significant Cut or broken skin, doesn't store as long but perfect for baking pies, cobblers; and D which is

those apples that are fed to Domestic animals or discarded.

The Worrells are hoping to find their way into various markets. They are currently negotiating with the Greeley-Evans School District, hoping to be part of their Farm to School Program. They may consider hosting school tours in the future.

The Worrells allow the public to come out and buy their fruit by appointment only. "We will take them through the orchard, tell them what is ripe, and help them choose what apples they want. We will help them pick their own apples." They also sell raspberries.

"Our apples are also sold exclusively at Heritage Market in Eaton. There are less expensive apples sold at the store, but there is no comparison to Worrell Farms produce."

As the cliché goes, "An apple a day keeps the doctor away," Greg truly believes that.



**Small acreage landowner, Greg Worrell, grows apples, pears, and peaches in Eaton, CO.**

## Tips for Managing Livestock in Winter

By K-State Research and Extension

Livestock producers are entering a time of year that, because of winter weather, can often be challenging for maintaining the health of their herds, but a host of management steps and best practices can help to get the animals through the tough times.

“Talking to a regional climatologist, we foresee a lot of fluctuation in weather,” said A.J. Tarpoff, a beef veterinarian with K-State Research and Extension.

“The fluctuations from warm to cold are stressful on any animal, so you have to be ready for that fluctuation.

“If it gets cold and it stays cold, we can manage that very easily. The animals get used to the cold, dry environment. But when we start mixing warm to cold, and a little bit of moisture – in other words, we combine wind, cold and a wet animal -- that leads to a little bit of trouble.”

Livestock that can be housed indoors -- such as chickens, swine and dairy cattle – may be protected from severe elements, but keeping them properly ventilated can be challenging.

“It’s hard to keep the fans and the ventilation adjusted appropriately because the incoming air is still

somewhat warmer during the day, but then it cools off during the night as we get the different weather fronts coming through,” said Joel DeRouchey, a livestock specialist with K-State Research and Extension. DeRouchey notes that fluctuations in indoor temperatures can cause mortalities in herds because the animals get stressed from the roller-coaster shifts. “It’s just like humans, from the standpoint if they’re going through any stress, changes in the outside temperature leads to humans developing respiratory challenges,” he said. “It’s the same for livestock, whether they’re inside or outside.

“The most important thing is maintaining a constant temperature. The goal is to bring animals inside to protect them from the elements, so we need to make sure our ventilation systems are managed correctly to provide that ideal environment.”

DeRouchey said that indoor ventilation also is important to keep air moisture, odor and nitrogen levels low.

For animals kept outside in feedlots, Tarpoff said one key is to provide dry bedding.

“Cattle have the right winter coat for cold weather, but whenever it starts to get windy, wet and cold, especially on frozen ground, the cattle want to find a nice, dry area to lie down and rest,” he said.

“Bedding those pens, giving them the opportunity to

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**During severe cold periods, producers need to feed a little more hay or other forage so that the animals’ natural heat source – the rumen – can do its work.**

## Winter Livestock Care from page 5

lie down and rest decreases the stress on those cattle and allows them to increase their comfort level so they can perform at a high rate even in stressful conditions.”

Tarpoft added that a box scraper is an important part of the equation in feedlots. Pens should be scraped routinely to level frozen areas, which will help to reduce foot injuries and the reluctance of animals to move to feed and water.

In outdoor pastures, the two K-State specialists suggest portable windbreaks, which provide shelter and can help with basic biosecurity.



“When cattle congregate in one area of the pasture for a long period of time, you build up environmental contaminants from manure,” Tarpoft said. “So move the portable windbreaks to different locations in the pasture so that you decrease the environmental contamination, which is especially important for newborn calves and control of scours.” DeRouchey notes that portable windbreaks can force cattle to walk out of low areas to water and feed.

“It doesn’t hurt those cows to walk out of those

low areas,” he said. “From an environmental standpoint, once we start providing a lot of feed or stationary feeders in those low areas, the manure buildup and the sanitation degrades really fast.” During severe cold periods, producers need to feed a little more hay or other forage so that the animals’ natural heat source – the rumen – can do its work. Cattle may be fed near windbreaks during times of extreme cold and snow, but DeRouchey notes that shouldn’t happen very often during the season.

Tarpoft added that water is equally important for livestock in the winter months as it is in the summer months.

“They are eating a lot more, so they need to be able to drink a lot more to balance the body’s homeostasis,” he said. “Check waterers regularly that they are not frozen over, there’s plenty of flow, and there’s plenty of volume for animals to drink from. A frozen tank can be detrimental to any livestock operation.”

The two K-State specialists also shared some ideas to help producers get themselves through the colder months. Specific to the upcoming calving season, one tip is to feed cattle in the evenings.

“Changing our feeding strategies to the evening hours, right at dusk, will increase the number of calves born during the daylight hours, which is when the producers are out checking those cattle more regularly,” Tarpoft said.

DeRouchey also reminded producers to make sure flashlights are in working order, and store extra batteries and clothing in case they get stranded or need to be out for extended periods in cold and snowy weather.

For more severe weather tips, producers may contact their local extension agent.





@coloradostewardship

The small acreage team and Retta Bruegger (Regional specialist for range management at CSU Extension) have worked hard to develop our social media in the past few months and we are excited to share with you a Facebook page we have developed! The page has monthly themes which guide our posts and the theme for January is yearly preparation. Follow us to learn about new resources and see the cool things we are up to!

The Instagram account (which came out last year) may look a little different if you haven't seen it in a while. This is because we are trying to broaden the content of the profile to better serve the diverse needs of the people we try to help. The Instagram account doesn't follow a monthly theme but it does try to post seasonally relevant information.  
@coloradostewardship

If you are hoping for more easy-access information related to land stewardship check us out!



## Fitting Cover Crops Into Farming

By John Rizza, Small Acreage Specialist, CSU Extension/NRCS

There is a cover crop to fit just about every farming situation! With all the recent talk about cover crops, we wanted to explore some of the most common species used in cover crop mixes. The costs and benefits of cover crops have been widely discussed. We have seen the utilization of cover crops in slowing erosion, improving soil structure, smothering weeds, enhancing nutrient and moisture availability, and even in helping control pests. Cover crops have also been shown to reduce inputs and increase profits because their benefits accumulate over the long term.

After spending some time with a few local vegetable and specialty crop farmers and discussing their cover crop needs in Western Colorado, I found many had a general desire to use a plant (cover crops) to increase organic matter in a field over time. I also found several similar questions from growers:

- How do I keep the soil armored when the cash crop is not in the field?
- What can cover crops offer in helping to suppress harmful weed invasions?

In the late summer, we designed a trial cover crop mix to help us answer some of these questions. Typical mixes include a variety of plants that can help achieve specific objectives, usually using 5 to 8 species. Our cover crop mix included 11 species: Cowpeas, Chickling Vetch, Austrian Winter Pea, Lentil, Forage Radish, Forage Turnip, Forage Collards, Yellow Mustard, Phacelia, Buckwheat, and Oats.

We knew that planting after harvest of the cash crop could introduce some weather challenges and wanted to see exactly how the species in the mix would behave. Working with several producers, we seeded 1,000 sf blocks that were irrigated and

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## Cover Crops from page 7

managed in various ways. The seeding window started at the beginning of August and closed at the end of August, depending on the grower and their cropping rotation.

Some preliminary information gathered on the plots are as follows:

- Seedlings typically germinated within 3 to 5 days of planting and watering.
- Some of the first plants to germinate include



**Cover mix , four weeks after seeding on above-ground drip tape irrigation**

- oats, radish, peas and buckwheat.
- Within 2 weeks of planting, we typically saw between 25 to 50 % emergence.
- Within 4 weeks of planting, seedlings were well established and vigorously growing and competing for resources.
- A few of the plots had the first signs of oat seed head formation at 12 weeks after planting.
- Plots were watered at irregular intervals until the irrigation water was no longer flowing, typically mid to late September in our area (Grand Valley, Mesa County, Colorado).
- Many of the species planted are moderately to very cold hardy. This allowed for the plots to

remain green after repeated exposure to heavy frosts.

Additional information will be presented after we see how these trial plots respond in the spring. That will include a variety of variables that address the various irrigation and management methods used. Ideally, the material gathered from this trial will help us to design a cover crop mix that meets the needs of our local growers while improving the condition of the soil.

### Key Cover Crop Resources

[Cover Crop Chart; USDA-ARS](#)

[Managing Cover Crops Profitably; SARE](#)

### **Resource Spot Light!**

#### **Low-Water Native Plant Guides Covering five regions of Colorado**

- [Front Range & Foothills](#)
- [Mountains 7500' and Above](#)
- [Prairie and Plains](#)
- [Southeastern Colorado](#)
- [Western Slope Below 7000'](#)

Available for download at CSU Extension



**Xeric Garden (rabbitbrush, blue stem  
ephedra, yarrow, yucca) in Grand Junction.  
Photo by Susan Carter**



## “Salida Yard and Garden” Radio Show

By Kurt Jones, CSU Extension Chaffee County

Beginning in April, 2017, Chaffee County Extension Director, Kurt Jones, began hosting a weekly radio program on KHEN radio, a local “low-power” radio station located in Salida, CO.



What began as a request to speak on the radio about local gardening issues and trends has become a regular feature on Tuesday afternoons from 1:00 until 1:30. Listeners can tune in to 106.9 FM, listen live on <http://www.khen.org/>, or listen to recorded pod casts of previous shows from the website. Salida Yard and Garden show is also underwritten by Café Dawn, a local coffee shop and community gathering spot.

Colorado Master Gardener volunteers regularly join Kurt as guests on the show. The Colorado Master Gardener program trains local volunteers on the science of gardening in exchange for volunteering to educate local citizens on gardening issues. Volunteer activities locally include educational booths at local Farmer’s Markets and the annual Home and Garden Show, one-on-one assistance answering gardening questions and concerns, youth gardening programming, newspaper and gardening blog articles, community greening outreach, noxious weed education, and now radio program guest appearances. Additional guests have included visiting extension agents and local gardening enthusi-

asts.

Once the live show is completed, the recording is edited for length and any audio abnormalities, then it is posted on the KHEN website. Following this, the station manager publishes a release on Facebook, tagging Kurt so it reaches followers of KHEN and Kurt Jones. Recent data suggests this program reaches 5,700 residents each week through this social media outlet. Analysis of podcast listening depends on the topic, but some of the top “downloads” were listened to more than 500 times.

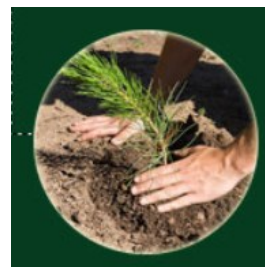
Plans for the program in 2018 include continued outreach from Colorado Master Gardener volunteers, a new program called Colorado Beekeeper Mentor volunteers will also be making regular appearances to discuss bee health and pollinator habitat issues, local gardening and landscaping professionals, and the initiation of a live call-in show where residents can call in with questions. Stay *tuned* for more exciting developments as this program enters its second year.



### Order Tree and Shrub Seedlings Now!

The Colorado State Forest Service Nursery provides landowners with the opportunity to purchase low-cost container and bare root seedlings to help successfully achieve conservation goals.

Learn more about tree inventory, how to plant, and where to order your trees and shrubs locally at <https://csfs.colostate.edu/buying-seedling-trees/>



## Grass Plots and Field Day

Kathleen Ray, CSU Extension Master Gardener

The annual pasture plot and small acreage forum took place in Hotchkiss Colorado again this year on October 6, 2017. The day in this North Fork community was perfect for such an event with crisp air and colors beginning to change along the river and hillsides. The Hotchkiss demonstration plot at the Delta County Fairgrounds of dryland and irrigated species looks strong and healthy. It grows on approximately 2 acres of land.



**Delta County Conservation District rents a grass drill to local landowners.**

The hands on demonstration, related to irrigated and dryland pastures, has become increasingly important due to the demand and need for quality pasture and hay. Small acreage owners are highly interested in learning more about specific seed mixes that will grow adequately, increasing water conservation practices, keeping their livestock healthy, reducing weeds, eradicating noxious varieties of weeds, and grow grasses that are suitable for marketable hay production.

### Quick Facts on Pastures During and After Drought:

- Small acreage pastures are most of the time too small to be a significant source of feed for grazing animals, but is excellent for them to exercise and graze on for short periods. Allow plants to regrow

6-8 inches before turning animals back onto the pasture.

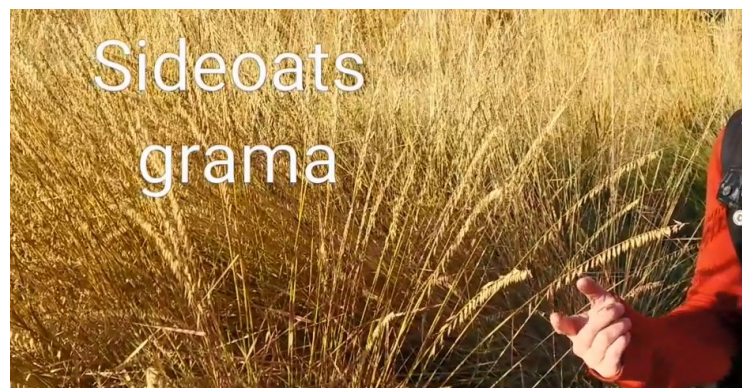
- Apply fertilizer according to soil test recommendations
- Control weeds

For a normal growing season, that which has normal moisture and temperatures, remember three important factors that affect how grasses respond to grazing:

- ♦ Frequency: As grazing increases grass production typically declines. Photosynthetic tissue that has been removed has little opportunity for growth.
- ♦ Intensity: Forage production declines if the plant experiences several defoliations compared to one.
- ♦ Season: During winter, plant reserves are maintained in the crown of the plant. Maintain 3 inches of stubble to keep your dormant grasses healthy and ready to grow again in the spring. Grasses can withstand greater defoliation during early growth stages, spring and early summer, and the leaves are high in nutrients and protein.

In cooperation with the Delta Conservation District, Delta County, CSU Extension, NRCS, Colorado Water Conservation Board, and others, grant funds were secured to install the Demonstration Plot.

It's well worth the time to visit the grass demonstration plot located at Hotchkiss County Fairgrounds, have a good lunch and enjoy the beauty of the North Fork Valley.



**The Hotchkiss plot includes 17 common irrigated and 17 dryland species of grasses best suited for pasture and hay in western Colorado.**

## Colorado Small Acreage Services Database

The source for landowners to find contractors, equipment, and services

[http://  
sam.ext.colostate.edu](http://sam.ext.colostate.edu)



Need help with weed control?

Have a small pasture seeding project?

Search the site today to find a local contractor!

**Contractors**—Advertise your services here!

This is a free service brought to you by USDA-NRCS, CSU Extension, and your local conservation district

For a list of upcoming events in your area visit CSU Extension Small Acreage

Management website

[sam.extension.colostate.edu/](http://sam.extension.colostate.edu/)

## Do you have a question about managing your small acreage?

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