Alfalfa ‘fabulous’ in removing carbon dioxide from atmosphere

By SUE ROESLER, Farm & Ranch Guide
Friday, November 5, 2010 12:16 PM CDT

Rebecca Phillips, plant physiologist at NGPRL, along with two interns, Sarah Waldron and Marla Striped-Face Collins, talks about the alfalfa carbon dioxide research at the Area 4 SCD Research Farm south of Mandan, N.D.

In 50 acres of lush alfalfa fields, scientists at the USDA-ARS Northern Great Plains Research Laboratory

(NGPRL) south of Mandan, N.D., are studying how much carbon dioxide is being taken out of the atmosphere.

There is increased interest in sequestering carbon dioxide to reduce global warming while at the same time maintaining active production agriculture, according to Rebecca Phillips, plant physiologist at NGPRL.

Phillips said scientists are studying ways changes in management such as putting on fertilizer at the right time, using no-till methods, planting the type of plants that take up more carbon dioxide such as alfalfa, adding organic matter, and improving nitrogen management can lessen carbon dioxide emissions in production agriculture.

By the end of July 2010, the Rangelander variety alfalfa was tall and blooming purple flowers. Producers toured the fields to see the ongoing research project that had begun last year.

In 2009, they no-till planted the perennial alfalfa without fertilizer and let it stand.

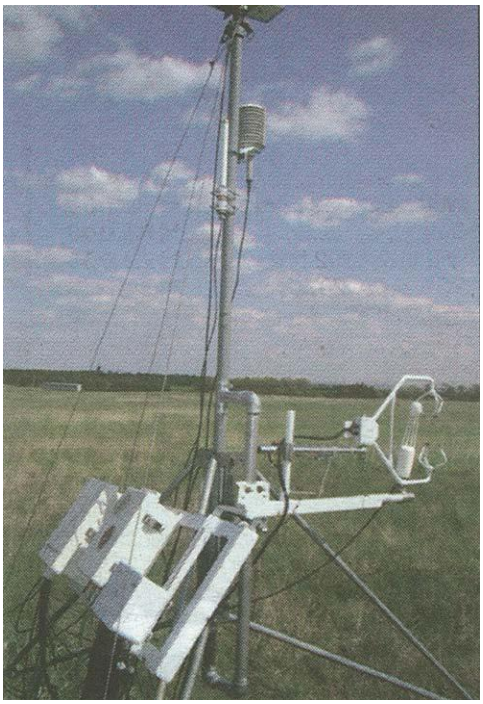
“We then let it go to seed, and found between July and November, the alfalfa had removed 1,400 pounds of carbon per acre from the atmosphere,” Phillips said. “Of course, this year it removed a great deal more.”

As a frame of reference, she used a nearby native prairie range of mostly cool season grasses.

"The native prairie is picking up carbon dioxide as well, but not as vigorously as the alfalfa," she said.

In 2010, scientists measured carbon dioxide and water vapor fluxes at the canopy over the entire alfalfa field at regular intervals since it was planted June 1.

"We're using this sophisticated weather system to measure water vapor and carbon dioxide 20 times per second," Phillips said, adding they use the covariance between the vertical wind and temperature, carbon dioxide and water to calculate the exchange of energy and matter continuously every half-hour.



The NGPRL scientists use this instrument to measure carbon data.

"We end up having a positive net uptake of carbon dioxide by these plants," Phillips said.

In addition to finding out the carbon dioxide measurements at the canopy level, the interns working with her were checking carbon dioxide uptake at the leaf level.

"They are looking at how well alfalfa photosynthesizes at a given level of light and under certain conditions and especially at differences in the canopy," she said.

In measuring the differences in the canopy, interns measured how the leaves respond to different levels of light at the bottom layer of the plant versus the middle layer and top level.

As expected, there was a significant decrease from the top layers of the plant to the bottom in terms of photosynthesis.

Alfalfa grows in several different vegetative stages, budding stages and reproductive stages, and they studied the photosynthesis levels at each stage.

The interns reported they didn't find significant differences in the photosynthesis levels at the various stages.

Last year, scientists conducted similar photosynthesis research on bromegrass in a pasture at the center, Phillips said.

"What we found is alfalfa is photosynthesizing on a per square meter basis close to twice as quickly as bromegrass," she said. "Its photosynthesis mechanism is such that it is taking carbon dioxide and photosynthesizing faster than the bromegrass."

Why is photosynthesis important?

Phillips said photosynthesis is important because carbon dioxide is a greenhouse gas, and plants use carbon dioxide to photosynthesize.

"Without it, they would not have a carbon source. Since plants use or take up carbon dioxide to grow, controls on photosynthesis are important," she said.

Corn is also a fast photosynthesizer, Phillips said. But alfalfa is very close to being as fast of a photosynthesizer as corn, she said.

Phillips said alfalfa is definitely a "carbon dioxide uptake powerhouse."

"Alfalfa is doing a fabulous job of removing carbon dioxide (from the atmosphere)," she said, adding there is a little bit more water use by the alfalfa, but it isn't three times more.

Basically, in the alfalfa field, they are demonstrating the environmental effects in terms of carbon dioxide being removed from the atmosphere, as well as production and production costs.

"We hope to determine the accumulation of carbon on an annual basis, taking into account carbon harvested and carbon transfer to soils," Phillips said. "We are also including other important greenhouse gases."

Some of the carbon dioxide is going into biomass and some of it is going below the ground which helps the soil quality, Phillips said.

Dave Archer, agricultural economist at NGPRL, is putting together the economic benefits of planting a perennial like alfalfa in cropping systems. The economics in 2009 was somewhat expensive because they wanted to make sure they could establish a good stand of alfalfa and it was not cut.

In 2010, they received a return on their initial investment. Phillips said they expect to see continued income from the alfalfa cuttings in

the next five years which is the limit of the research project. Input costs were kept low, but the field was sprayed for weeds this spring (but not in 2009) and phosphorus was added, she said.

In addition, they found it was a good hay with good feed value. They calculated the feed value as $56 per ton, with a 3.2 ton per acre yield for its first cutting ($179 per acre total income). Protein level at the first cutting was around 25 percent.

This field of alfalfa was growing tall and blooming at the end of July at the research farm.

"The reason we used a perennial forb is we thought it removed more carbon dioxide from the air than an annual crop, and we thought it had use as a possible viable cellulosic feedstock as well as being a hay for producers," she said.

In addition, they knew alfalfa grew well in the Northern Plains states.

"This should be a win-win situation with the economic positives of planting alfalfa as well as its positive environmental impacts," Phillips said.

While she was unsure of the viability of alfalfa as a cellulosic feedstock, she said scientists at Iowa State are working on advanced biofuel processing options, including nitrogen capture, for alfalfa.