Checking in with CenUSA

Sustainable Production and Distribution of Bioenergy for the Central US

CenUSA Bioenergy is a multidisciplinary project funded by the U.S. Department of Agriculture-National Institute of Food and Agriculture (USDA-NIFA). The goal of the project is to research the production and use of perennial grasses on marginal lands for use as alternative biofuels and bioproducts. Learn more about CenUSA at www.cenusa.iastate.edu.

Rob Mitchell[1] is a research agronomist for the USDA's Agricultural Research Service (USDA-ARS). In December 2018, Mitchell spoke about his work and involvement with CenUSA in the areas of feedstock development and sustainable feedstock production systems with CenUSA Communications Intern Tyler Worsham.[2] A highlight of the discussion was how Mitchell, his team and other co-project leaders were able to develop and release 'Liberty,' a switchgrass hybrid that takes advantage of the various strengths of different switchgrass varieties from across the United States.

How did you initially get involved with CenUSA?

"Ken Vogel and I met with the participants at Iowa State before the proposal was submitted and we talked about opportunities to collaborate. Ken Vogel and I first met with Robert Brown, Jill Euken and David Laird, and we discussed the possibility of presenting a proposal together. CenUSA came out of that meeting."

Rob Mitchell

What made you the ideal candidate for your co-project leadership position?

"I have a background with switchgrass and other warm season grasses. I also have a good understanding of the agronomics and other aspects of plant growth and development that need to be evaluated."

In what ways did the project broaden and challenge your professional knowledge and skill set?

"One of the ways was the logistics required to carry out a project of this magnitude. It was really an amazing feat when you think about how many plots and fields we established. Coordinating field sites and handling a lot

[1] Learn more about Rob Mitchell at https://www.ars.usda.gov/plains-area/lincoln-ne/wheat-sorghum-and-forage-research/people/robert-mitchell/

[2] All of the words and ideas expressed in this interview fairly and accurately represent the speaker. Some quotes may be paraphrased for brevity and clarity. The opinions expressed in herein do not necessarily reflect those of Iowa State University, USDA-NIFA, Purdue University, Ohio State University, USDA-ARS, the University of Minnesota, the University of Nebraska, Lincoln, the University of Vermont, or the University of Wisconsin.

of the data from people involved in the project were pretty amazing feats. That stretched me a lot."

Have you worked in any other projects as large or as well-funded as CenUSA

"No, this is the largest project that I've ever worked on. In fact, it's one of the largest grants with which I am familiar that have ever been awarded through NIFA (National Institute of Food and Agriculture)."

What was your experience having worked in other projects?

"I've worked on a number of multi-institution grant projects and I am a part of two other large grants right now. I've also had experience with DOE (Department of Energy) grants. One of the early biomass feedstock programs that was around was called the Sun Grant Initiative, and I was an active participant in Sun Grant. I also participated in numerous other grants from different funding agencies."

What made CenUSA different from these other projects?

"The scale was a huge difference for one thing. Looking at it from this side of the project, one of the things that I see now is that it allowed us to evaluate feedstocks at a scale that we would have otherwise never been able to do. For most of our small plot trials, we will coordinate with one, two or maybe even three locations, but to have plant material scattered around more than 50 sites in the central and eastern U.S. is really unprecedented."

To what new ideas and disciplines were you exposed as a part of your experience with CenUSA?

"The biggest new exposures were probably to biochar and the fast pyrolysis platform. Those were the two areas where I had very limited experience before CenUSA, but being introduced to that platform was a real eye-opener to me. Prior to that, we'd been focusing on cellulosic ethanol for the last decade-and-a-half, so focusing on fast pyrolysis was a change in mindset for us. Those two areas were some of the biggest changes and were both areas in which I had very limited experience."

What was the extent of your involvement with pyrolysis and biochar?

"When we have historically evaluated plant materials, we have evaluated them from a cellulosic ethanol perspective, so I have a pretty good understanding of that whole process. As we were moving into the fast pyrolysis side, I didn't know what plant constituents were important or which ones maybe even had a negative impact on fast pyrolysis processes. That was new to me.

When I got started with CenUSA on the biochar side of things, I had really not evaluated biochar from an agronomic value perspective. Having been exposed to the work that Dr. (David) Laird has been doing and to some of the work that is now coming out of CenUSA, it was really eye-opening to see the positive attributes of biochar. I was kind of suspicious of the true value of biochar prior to this project because I had limited exposure to it. Now I see a lot of value in biochar as a soil amendment."

Were there any obstacles that you and your team encountered or didn't expect in your work?

"No, not really. We went going in knowing that one of the biggest challenges would be coordinating so many scientists. It actually ended up being a great pleasure working with so many people. Ken Moore did a great job leading the project. It's also hard to understate the value that Anne Kinzel brought to CenUSA. She did a really great job keeping us on task with all of our reporting requirements because in a lot of ways, those onerous items that show up in these large scale grants are making sure you do a good job at reporting what you're doing.

I knew there wouldn't be any issue with reporting things in a scientific journal because it was a collection from a bunch of very productive scientists. The unknown for me was all of the administrative side. Ken and Anne did a wonderful job in that area. Jeff Volenec and I worked well together. He did a great job on the project and was an invaluable team member."

What were some of the noteworthy discoveries or successes that you achieved through your research?

"Probably one of the biggest things that we were able to achieve was releasing a bioenergy-specific switchgrass cultivar. Releasing 'Liberty' switchgrass was certainly a huge milestone for us. The other, as I mentioned earlier, was our ability to test the different plant material at so many different locations. We had over 50 field sites as a part of CenUSA, so having the opportunity to evaluate plant material at that many locations was just incredibly valuable.

The other thing that I would say was a huge accomplishment for us was that we were able to get the Extension people involved in the bioenergy area, which we have never really been able to do before at scale. We had demonstration sites scattered across the CenUSA states, and we had field days at those sites, particularly in Nebraska where we had two demonstration fields. Those field days were well received and really allowed farmers to get their first exposure to some of these bioenergy crops. Those were some big leaps forward, in my mind."

What was the extent of your involvement with Extension?

"I collaborated a lot with the Extension personnel. Some of the things I did were to make all of the seeding recommendations, put together all of the seed materials for the demonstration fields that we established and provided management guidance to Extension personnel. One of the things that we had done prior to CenUSA was write a large-scale Extension publication that was on establishing and managing switchgrass for biomass energy production. We were able to get that in the hands of a lot of people.

We updated that during the CenUSA project as well. I was involved in the establishment and management side of the demonstration plots and answered questions from a lot of individuals. I organized a lot of their sampling, and I was able to provide some guidance for a lot of their sampling activities there."

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How did you participate with the Casler/ Vogel team that was instrumental in the development of "Liberty" and other new varieties?

"I was the one who did the agronomic field testing of 'Liberty,' so that was really one of my key roles, doing the field evaluations for 'Liberty.'"

What went into that process?

"Well, the establishment and management side is pretty broad, so one of the things we had to do was develop a good understanding of what herbicides the particular cultivar could tolerate and what was necessary for establishment. We did the field work of evaluating the necessary herbicides and measures for establishing 'Liberty' and looked at nitrogen fertilizer recommendations which we would then broaden through the CenUSA project. We then looked at harvesting effects at different times of the year.

Traditionally, we harvested most of our plant material for biomass energy around anthesis (flowering period of a plant). That would have been around August 1 here in Nebraska. As we began evaluating more and more of our biomass types, we found that we could harvest more precisely and harvest a more desirable feedstock after frost. We really changed our harvesting paradigm, and a lot of that came through our evaluations of 'Liberty.'"

What are your thoughts on the new switchgrass varieties being developed, and how will they contribute to the potential of switchgrass as a biofeedstock?

"One of the things I see is a really big potential for switchgrass varieties that have a higher yield. Yield potential is really one of the big limitations for any of our biomass feedstocks.

One of the things that we saw with CenUSA, which was a really nice evaluation for us, was that we were able to evaluate 'Liberty' and some of our other plant material at a field scale. We weren't harvesting it with small plot equipment or hand-harvesting, it was being harvested with swathers and then baled in the field. Those were some real-world evaluations for these biomass feedstocks."

Where do you see switchgrass breeding in 20 years?

"I see switchgrass cultivars that probably yield 10 tons of biomass per acre at the field scale. I think we have the potential for moving forward to that 10 ton per yield goal. That would be a big step forward because if we can reliably produce 10 tons at the field scale, that makes it very, very competitive as a biomass feedstock."

How do you think that will be achieved?

"One of the areas that is probably the most poorly understood is the plant's ability to use nitrogen, so as we look at ways to evaluate some of the nitrogen-use efficiency and understand nitrogen fertilizer rates. I think that is going to be a big step forward. Mike Casler is starting to do some of that work, and we've got some plots in the ground that we are going to work with as well. Being able to select for plant material that not only has excellent water-use efficiency, but also nitrogen-use efficiency will be very helpful for moving us forward."

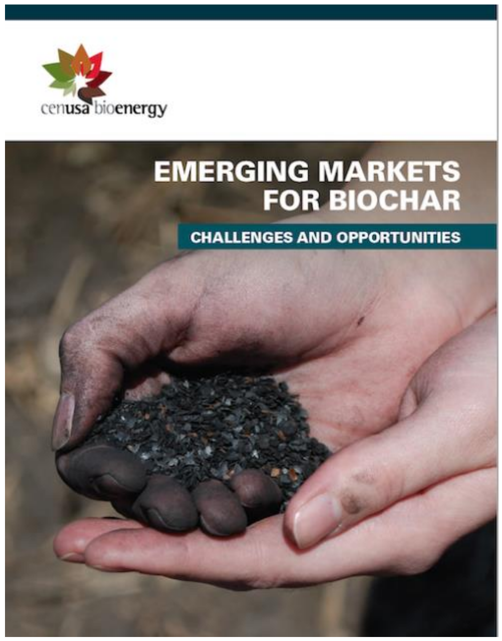
What is it about switchgrass from an agronomic perspective that makes it well suited for marginal soils?

It sounds kind of funny to say it out loud, but one of the things that makes switchgrass agronomically friendly is its seed. It's got a pretty small seed, but it's also pretty slick, so it flows well through a drill. Some of the problems we have with the other native warm-season grasses are that they're kind of a pain to deal with from a drill perspective.

Switchgrass flows well, it typically has very high germination rates which can do a really good job of controlling quality in the seed lots. It tends to be a pretty vigorous seedling, so as we've selected for improved seedling vigor in some of these switchgrasses, those are agronomic characteristics that make it pretty desirable. Because establishment is such a huge key for us, if you can get it established and have a harvestable yield within the first year, it makes the economics really attractive."

What are the biggest agronomic obstacles to increased switchgrass planting on marginal land?

"One of the biggest barriers right now is a viable market for bioenergy. For the past decade or two, we've been able to grow switchgrass fairly reliably, but without a dedicated switchgrass feedstock market, that has been the biggest barrier. There's a lot of interest in switchgrass from a grazing perspective, as well as interest in switchgrass as a component of feedlot rations, but from a bioenergy feedstock perspective, it's all up to the market when it comes to growing at a large-scale on marginally productive cropland."



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How do you think that market can be created and fostered? Do you think CenUSA has helped address these problems?

"I think CenUSA has helped address a lot of those problems, and one of the biggest problems is really the large-scale operation of cellulosic ethanol plants. There are a few now that have been started up in the central United States. At some point, as we potentially make the transition from using corn stalks to switchgrass, that opens up a market opportunity for switchgrass that isn't available now. That's probably the biggest hurdle, making it commercially feasible and developing it that way."

What do you think needs to be done from the research side of things to reduce those obstacles?

"We need to continue to demonstrate economic feasibility. That's one aspect. The other is the continued use of long term research projects to demonstrate the long term sustainability on marginally productive lands. We've got one study in which we are comparing switchgrass and corn grown on marginally productive land that we started in 1998. That long term project is still ongoing.

We're now starting to produce some long term data on the effects of nitrogen fertilizer and the soil-organic carbon changes on switchgrass compared to corn. We are carrying on some of these long-term projects that we started during the CenUSA project. As we carry those on, we will just get a better understanding of the long-term sustainability of switchgrass, but also the ability to maintain stands over the long-term so we can harvest productive stands for a decade or more."

What is one of the most important or most interesting facets of your work that you would like for the general public to understand?

"It's an interesting process in that we're working on research that maybe doesn't have a direct application for the economy at this point, but what we are doing here has the potential to develop new renewable transportation fuels that are positive for the environment and for farmers.

To think that we might be utilizing switchgrass to produce ethanol or bio-oil in the next decade or two is exciting. Again, these are long-term processes that you just never know how they are going to work out. One of the things we do know is that the information that we are gathering now is certainly not going to be wasted. If necessary, we can put this on the shelf. As we begin to deplete more and more of our energy resources, as fossil fuels become less abundant, we can take these switchgrass projects off the shelf and put them into practice pretty quickly."

How long do you think it will be until we will be able to use those switchgrasses for transportation fuels?

"Well, I really think that we could do it now because we have the technology to do it. The limitation is really the economics of that process. We could slide switchgrass as a feedstock into that process now, We've got all of the pieces in place. It just needs to become more economically feasible to move forward.

How will you take your experience with CenUSA and put it to use in future projects?

"One of the biggest things in the work we do in our field sciences is collaboration with other scientists. One of the real values of CenUSA was that it allowed us to develop some very productive collaborations with other scientists, and we are continuing those now. Even though we finished our work with CenUSA, there are a number of us who are continuing to work together to move our research forward."

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In what new directions do you hope to take your own research?

"I'll continue to do a lot of work on the agronomics of switchgrass and looking at harvest and storage management. We'll continue to evaluate plant materials with NIRS (near infrared reflectance spectroscopy) so we can get a better understanding of the constituents in those plant materials. We're going to continue moving forward with agronomics and testing new plant materials as our research geneticists get those materials developed and field-ready. In many ways we will do the same things we've been doing, looking at new ways to address these issues with nitrogen-use efficiency and trying to better understand mineral nutrition in switchgrass and other native warm-season grasses as I mentioned earlier."

Rob Mitchell CenUSA Bioenergy Work Product

Extension and Outreach

- ✓ Fact Sheet: Guidelines to Growing Perennial Grasses for Biofuel and Bioproducts. **Rob Mitchell**, USDA-ARS. 2017. https://cenusa.iastate.edu/files/cenusa_2019_010.pdf

- ✓ Fact Sheet: Switchgrass (Panicum virgatum) for Biofuel Production. **Rob Mitchell**, Ken Vogel & Marty Schmer USDA-ARS. 2016. https://cenusa.iastate.edu/files/cenusa_2019_008.pdf
- ✓ Fact Sheet: Control Weeds in Switchgrass (Panicum Virgatum L.) Grown for Biomass. **Rob Mitchell**, USDA-ARS. 2014. https://cenusa.iastate.edu/files/cenusa_2019_009.pdf
- ✓ Fact Sheet: Switchgrass (Panicum virgatum L) Stand Establishment Key Factors for Success. **Rob Mitchell**, USDA-ARS. 2013. https://cenusa.iastate.edu/files/cenusa_2019_012.pdf
- ✓ Fact Sheet: Test Plots Show How Perennial Grasses Can Be Grown for Biofuels. **Rob Mitchell**, USDA-ARS. & Jeff Volenec, Purdue Univ. 2013. https://cenusa.iastate.edu/files/cenusa_2019_013.pdf
- ✓ Instructional Video: Commercialization Update: Opportunities for Perennial Biofeedstocks. **Rob Mitchell**, USDA-ARS. 2014. (2:18). https://www.youtube.com/watch?v=jtrGuZ-DDAs
- ✓ Instructional Video: Switchgrass Planting Practices for Stand Establishment. **Rob Mitchell**, USDA-ARS. 2013. (5:17). https://www.youtube.com/watch?v=vwBQ3aYpfmM
- ✓ Instructional Video: Harvesting Native Grass for Biofuel Production (Captions). **Rob Mitchell**, USDA-ARS. 2012. (2:58). https://www.youtube.com/watch?v=ybDGWJa6pzc
- ✓ Instructional Video: Drill Calibration Walk Through (Captions). 2012. (4:59). **Rob Mitchell**, USDA-ARS. https://www.youtube.com/watch?v=izBHivo5xfw
- ✓ Instructional Video: No-Till Drill Calibration for Switchgrass. **Rob Mitchell** (USDA-ARS). 2012. https://www.youtube.com/watch?v=7TPLfWLkd_U
- ✓ Webinar: Switchgrass Stand Establishment, Cultivar Development and Acreage Needs for a Viable Biofuel Industry. **Rob Mitchell** (USDA-ARS). 2017. (33:24). https://www.youtube.com/watch?v=U5Y9sa5b_3U
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Publications

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- ✓ Bonin, C.L., R.B. Fidel, C. Banik, D.A. Laird, **R. Mitchell** & E.A. Heaton. 2018. Perennial biomass crop establishment, community characteristics, and productivity in the upper US Midwest: Effects of cropping systems seed mixtures and biochar applications. Eur. J. Agron. 101: 121-128

- ✓ Dien, B.S, **R. Mitchell**, M. Bowman, V. Jin, J. Quarterman, M. Schmer, V. Singh & P. Slininger. Bioconversion of pelletized big bluestem, switchgrass, and low-diversity grass mixtures into sugars and bioethanol. Frontiers in Energy Res. doi: 10.3389/fenrg.2018.00129. 2018

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