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.

USDA Research Geneticist Michael Casler[1] was willing to elaborate on this process and his involvement as a CenUSA co-project director with the project. Dr. Casler spoke about his work and involvement with CenUSA in the areas of feedstock development and sustainable feedstock production systems with CenUSA Communications Tyler Worsham in November 2018.[2] Casler detailed the challenges of plant breeding and trial establishment in the field.

How did you initially get involved with CenUSA?

"I was invited from the beginning to be one of the original principle investigators on the project to participate in the planning stages and development of the grant proposal. The group decided right away that it was going to be a multi-state project in the north-central region with a focus on perennial grasses. I've been working on perennial warm season grasses for bioenergy for about 20 years, so I guess I was a logical choice."

What we're trying to do is develop late flowering varieties. The reason we want later flowering is because we want to be able to utilize the entire growing season. *Mike Casler*

Have you worked on any other projects of a similar size or funding?

"Oh no, of all the grants and projects that I've had, this was clearly the highest level of funding and the most extensive project in which I've participated."

What made you the ideal candidate for a feedstock development leadership position?

"There were two of us who were leaders in feedstock development, Ken Vogel and I. Before he retired, we were both actively breeding switchgrass and bluestem for bioenergy. We have the largest programs in the

[1] Learn more about Mike Casler at https://www.ars.usda.gov/midwest-area/madison-wi/us-dairy-forage-research-center/dairy-forage-research/people/michael-d-casler

[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.

Midwest area, and we've been doing it for a long time, so it just seemed logical for the two of us to be the leaders of that activity. I think you'd have to call us co-leaders. It wasn't just me."

Describe your specific role in feedstock development research for the project.

"My specific role involved two things. We were funded for the six- year period to be able to continue the breeding work we've been doing, and to also set up a new multi-location testing system for candidate varieties. We established trials at thirteen locations with switchgrass and bluestem, and we essentially ran those trials for that six-year period, testing all of these candidate varieties so that now we have this huge database to use for the release of new varieties. We haven't made those decisions yet, but we're in the process of doing that right now. That's pretty much it, conducting the multi-regional trials and continuing the breeding program developing new populations."

How did the project challenge or broaden your knowledge and skill set?

"The biggest challenge was not science; it was organizing everything from people to all of these trials across all of these states and getting people to do everything the same way. Our goal was to set up uniform trials that are conducted the same way at every location. I must say, that was a challenge, but people were really cooperative.

For the most part, everything went pretty well, but it didn't just happen by happenstance. It required a lot of coordination and a lot of oversight on the part of my technician and myself. It wasn't the science. It was dealing with people."

Many of those populations will be going into multiple-location trials over the next few years, so CenUSA is actually going to have a legacy that's going to take us a little bit of time to establish."

What was the need for this project? Was it a lack of communication or lack of feedback between projects throughout the country?

"No, you see, Ken Vogel and I had been working together for years. We would test each other's breeding materials and collaborated together very well, but one thing that's really important with these perennial warm season grasses for energy is that the varieties we develop are narrowly adapted geographically. Any one variety is usually adaptive to only two or three hardiness zones. Ken Vogel would adapt varieties to Kansas, Nebraska and South Dakota, and I would be developing varieties that are adaptive to Wisconsin and maybe northern Illinois, northern Iowa, Minnesota and Michigan.

What we needed was a bigger testing region. We needed broader testing, more collaborators to test these varieties in order to get a really good idea of which candidate varieties are best adapted to which regions. That's what CenUSA did for us. It gave us the platform to be able to do that. The platform essentially helped us to get collaborators in multiple states. I think we had nine-or-so states involved with funding to support those field trials. What they were doing for those five or six years of the CenUSA project was testing the varieties Ken (Vogel) and I had been developing for the last 20 years, as well as other varieties from other breeding programs."

What are the most promising approaches to increasing switchgrass yields in the *Midwest?*

"What we're trying to do is develop late flowering varieties. The reason we want later flowering is because we want to be able to utilize the entire growing season. Locally adapted varieties and traditional varieties that we've collected from around here in prairie and savannah sites are early flowering, and they're really

wasting six to eight weeks of the growing season. We're trying to develop late flowering types that have sufficient winter hardiness so that they'll survive here and provide sustainable production. We basically want them to grow all the way up to killing frost. That's our goal so that we're accumulating biomass during the entire growing season."

Could you describe the process that geneticists use to produce higher yields of grass like 'Liberty', for example?

"For 'Liberty', that was a 20-year process. Ken Vogel made hybrids between what we call upland and lowland types of switchgrass. The upland type is a northern type with good winter hardiness but very early flowering, and the lowland type is a southern type that's very late flowering but doesn't have much winter hardiness. He made those crosses in the greenhouse, planting thousands upon thousands of progenies in the field and went through two generations of selection for late flowering, winter survival and biomass. He and I then tested those candidate varieties. There were five of them, and he decided that one of those was going to be released as the variety called 'Liberty'. 'Liberty' is essentially a hybrid. It combines late flowering from the south and winter hardiness from the north into a population that is actually very winter hardy and very late flowering."

Did you have any involvement in the development of 'Liberty'?

"I wasn't involved in development, only the testing."

Where do you hope to take your CenUSA research from here?

"Some of the breeding work that we did during the CenUSA period has yet to be tested because the project has only been completed for a few months. Many of those populations will be going into multiple-location trials over the next few years, so CenUSA is actually going to have a legacy that's going to take us a little bit of time to establish. It's going to take us a few years before we know exactly what that legacy is, but that's probably going to be a legacy of some additional new varieties that will be developed as a result of some of the work we did during CenUSA."

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https://cenusa.iastate.edu/files/cenusa_2019_075.pdf

How have advancements in genome research made developing switchgrass varieties easier?

"No, it hasn't been easier. It has been quite the opposite! It's more complicated because we've had to learn genomic techniques. CenUSA helped us develop what we call a genomic selection platform for switchgrass. We went through about five years of developing and implementing that, and now in 2019, we'll be starting to put those materials in the field to test them and determine whether it worked.

I won't know whether or not it worked or how well it worked for another four years, but it was a challenge and a lot of work. It was a struggle to learn some of those techniques and develop the right genotyping platform to support that. We feel pretty good about it. We feel like we've got it moving along and that we developed it. We're hoping that it worked."

Are there any other high biomass cultivars besides 'Liberty' that are being developed?

"Yeah, there are a lot of them that are being developed. There are at least 10 different switchgrass breeding programs in North America, one in Canada and nine or 10 in the United States depending on how you want to define them.

All of those breeding programs are working on developing new bioenergy varieties. The Nebraska program and my program in Wisconsin are just two of those 10. The others are working on similar or slightly different objectives if they're in a different geographic area like the program in Georgia. They might have some different specific research objectives, but their ultimate goal is similar to mine, higher biomass."

I've been told that one of the goals is to achieve 10 tons/acre. How close are you to achieving that amount if it hasn't been already?

"We're about halfway there in the north-central regions. In terms of where we were 20 years ago, I think we've made it halfway there. Maybe it will be another 20 years to get there. I hope not, but it might be."

Were there any new disciplines that you were exposed to that you were involved with directly or that you saw from other people?

"Yeah, I would probably say developing genomic tools to use in plant breeding. That was fairly new for me, and CenUSA was very helpful in being able to do that."

What were the challenges of having to learn those new disciplines and new ideas?

"Well, mainly it's just new technologies. The technology is changing rapidly, so once we learn something new, somebody's telling me, 'you have to learn this new thing!' The fact that it's changing so rapidly means you can't just sit back on your laurels and say, 'Okay, I've got it figured out.' All of a sudden, the technology changes, and you have to adapt to those changes.

Otherwise, they're cookbook procedures, so it's just a matter of figuring out how to extract DNA, how to process the DNA and how to get it sequenced. It's not like rocket science, it's pretty straightforward. It's just constantly changing."

So how do you keep up with those changes?

"I rely a lot on my colleagues, a lot on the people who are more involved in the development of those changes, on the people who are more basic geneticists, genomics people and bioinformatics people. I rely a lot on them for advice."

What were some of your noteworthy developments, discoveries, and different opportunities that you didn't expect?

"I think we got what we expected out of the project. What we expected was that we would be able to continue the breeding programs, continue making improvements, continue making new candidate varieties and also set up this multi-locational regional resting system at these thirteen locations. Those were our goals and we feel we satisfactorily completed those goals."

What do you think is the most interesting facet of your research that you would like the average interested public to know?

"I don't know. The most interesting thing to me is that we have already developed new varieties that are higher in biomass yield and are actually

able to produce sustainable biomass that the economists say is at a yield level that is economically sustainable year-in and year-out. In other words, the models that we have and the economic analyses that we've done say that farmers can grow these things and produce economically sustainable biomass.

The only problem is that we don't have markets for it yet. I think that's the most interesting thing we've done. We've gotten at least one variety out there. We have several others coming down the pipeline that have addressed these issues, but there are no markets in order to take off with it yet."

Where do you see switchgrass breeding 20 years from now?

"I would hope that it (research) continues. DOE (Department of Energy) is still funding switchgrass and USDA-NIFA is still funding the development of bioenergy systems, so I hope it continues. I hope people figure out a way to develop markets for this. I'd like to see perennial bioenergy crops be a viable alternative to fossil fuels.

One of the great things about them is that these are crops that can be grown on marginal lands, especially marginal lands for which there are problems like erosion and nutrient loading. These bioenergy systems we're proposing can really have a dual purpose. One is to produce energy, and the other is to solve environmental problems that we have. So yeah, my hope is that the markets develop and that the mechanisms stay in place to strengthen these markets so that this can become a reality."

You mentioned where research is going. Where do you hope to use and apply your own area of research in the future?

"I'm just going to continue to develop new varieties and continue toward that 10 ton per-acre goal. Like I said, I feel that the data suggests we're only halfway there. I just want to get as close as I can while I still have money to do it."

Mike Casler CenUSA Bioenergy Work Product

Extension and Outreach

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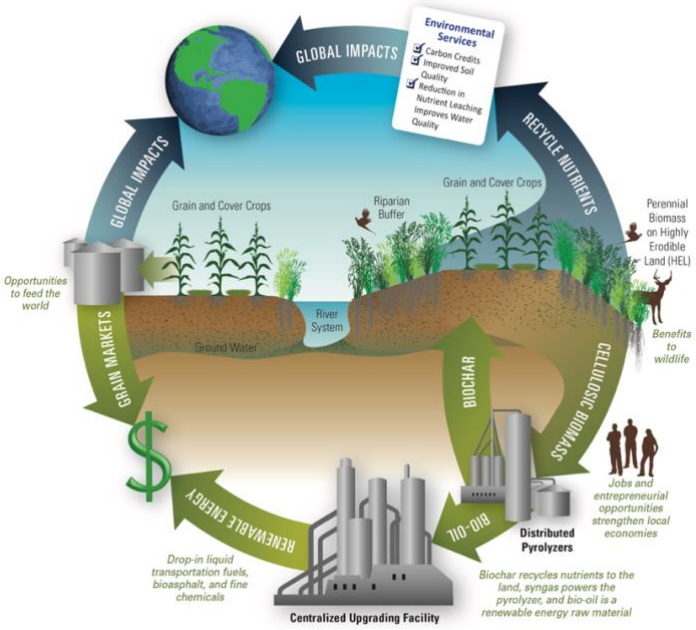

CenUSA Bioenergy Vision

Learn more about CenUSA at www.cenusa.iastate.edu

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