Eric Hall (EH): All right. Well, welcome back to oursecond episode of the Destination Biotech podcast. I am Eric Hall, your host, along with my co-host—

Matt Shafer (Matt): I'm Matt Shafer, the biotech student outreach intern.

EH: And we're here today with a very special guest, Dr. Michelle Soupir, a professor in Ag and Biosystems Engineering. Welcome Michelle.

Michelle Soupir (MS): Thank you, Eric. Thank you, Matt. It's nice to be here today.

EH: We're happy to have you. We've had such a such a long relationship with you and we've done some really exciting things curriculum-wise with teachers and with students and we're happy to have you with us here today. So we'll just start off, tell us a little bit about yourself and your journey to getting to Iowa State and being a water chick, right?

MS: Yeah, that's my X handle. It used to be a Twitter handle. So yeah, so I'm from El Dorado, Kansas. It's a fairly small town outside of Wichita and just grew up in the country. One of my grandparents farmed and so I spent a lot of time outside enjoying the environment and also being around agriculture. When I decided to go to Kansas State, I was looking at different options, including environmental science as well as some different engineering options, and that's where I found the Biological and Agricultural Engineering Department. It's a pretty small department, but it really hit a lot of the buttons for me given the mix of engineering, using a lot of math, applied sciences, and then also the chance to work out in the external environment. After I graduated, I worked for an environmental engineering consulting firm for about a year and a half, and then decided to really focus in on research and loved the idea of being able to teach, being able to work with students and also being able to learn more about the environment and how we could reduce pollution movement. So after grad school I had a job offer at Iowa State in the Department of Ag and Biosystems Engineering and the rest is history. So here I am. Yeah, still here.

EH: Then you finally debuted on a podcast after that many years, right?

MS: Yes. Finally Famous.

EH: Exactly, right, well…

MS: Maybe?

EH: We'll see what we can do. So when you were growing up, when you were in high school, when you were in middle school, did you feel like you had an aptitude for what you do now, or did you, did you feel like you had to grow into it a little bit? Or what were your thoughts at that point in your life about where you wanted to go?

MS: Yeah, you know, I knew that I enjoyed being outside. I enjoyed being in nature. I definitely was making observations about the environment. You know, there was a lot, we lived near a small creek, there was a lot

of sediment. It was very murky. Sometimes it looked like there was kind of an oily film on it. So I was definitely paying attention and seeing different things that were happening. The stream banks weren't stable, so in some places there would be a really large drop off and that scouring that takes place during high flow conditions. And then I was good in math in high school. And so that was really when the guidance counselor at the school kind of said, "Hey, why don't you check out engineering?" Back then, engineering wasn't something that there was a lot of high school, middle school education about, and so I honestly didn't even know what it was. When I went to a campus visit to Kansas State, I was actually able to meet up with a faculty member in that department, and he was so enthusiastic and he told me all about the different ways that we could study agriculture and understand how it interacts with the environment, connect it to precipitation, weather patterns, and then also just having the chance to be able to apply the math and science skills that I had. And then of course lots of good job opportunities in those spaces. So it wasn't something that I really learned about until I started looking at different colleges.

Matt: So, we hear a lot about water quality on the news. So could you tell me a little bit about why water quality is such an issue, specifically to Iowa?

MS: Yeah, well, we can start out by thinking about how do the different pollutants that are generated across different types of sources, how do they get into our water supply? And we can think about this in two different ways, and this is how it's classified by the federal government, as point and non-point sources of pollution. And so you can see here there are two different examples. The picture on the left is a point source, basically a discharge coming from some kind of a factory or industrial facility. And here the water is coming out of the pipe and the pollutants are being directly discharged. So we call that a point source of pollution. The other kind of pollution is a nonpoint source. So when you think about the state of Iowa, we have a lot of areas that are in agricultural fields and how the pollutants get from those types of landscapes into our waters is very different. An agricultural field may receive fertilizer application, different types of pesticides such as insecticides or herbicides, and while those are greatly beneficial to crop growth, when it rains, those pollutants can be picked up and carried into our surface waters. And so when we think about the differences between point and non-point sources of pollution, there's one other thing that's important to consider, and it's actually very important across the state of Iowa. We have very rich soils that are high in organic matter and they tend to hold on to water, and so in order for farmers and producers to get out into fields, to be able to plant their crops, and also for the crops to be able to grow well, we need to be able to access dry soil. And so what we have done is we have installed drainage networks across much of the state of Iowa. These tile drainage networks are similar to what we might see in an urban area, so like a storm water system where the water is collected as it flow off of streets, goes into pipes underneath the ground and then is discharged into a nearby streamer river. We've done the same thing in agriculture to try and help support growing crops. While these drainage systems are so important for our ag industry across the state, they are a way that different pollutants can

move through the soil profile more quickly. And then once those pollutants get into those tile drainage network or tile drain pipes, they can then move directly into surface waters.

EH: So, it would seem that if we're starting to move some of these pollutants through the tile drainage system network that there are some opportunities there, right, to try to reduce, try to mitigate some of that happening and is that something that your research focuses on?

MS: Yes, yes. We do a lot of work in the area of trying to better understand how these pollutants move through the environment. One example is nitrogen. It's very, very important in crop growth. It has a negative charge and because of that, it's able to move very easily through the soil profile. And so after a rain event, the nitrogen that's intended for plants and for different types of crops can move through that soil profile, be intersected by those tile drains and the move off site very quickly. And so that's what we do in our group. We try to understand what are some things that we can do in the field, what are some things that we can do at the edge of the edge of the field, to try and help reduce the movement of different pollutants into the environment?

EH: And so just sort of a quick tangent here, you use the word group. Is it more than just you doing this research or who all is involved in everything?

MS: Yeah, of course, I often use the word “we” instead of “I” because I could do very little without the many amazing students and staff that have worked with me for many different years. So our group actually has full-time research staff members, and so those folks are able to, you know, manage our different field sites’ and they're very important in supporting our students to make sure that the students have kind of that long-term knowledge as far as how to do data collection, how different sites work, how to get in and out of the field. And so our students then are, we have graduate students and we have undergraduate students, the graduate students are of course pursuing either master’s or doctoral degrees, while the undergraduate students are typically working hourly, and they can often just come in between classes to work for a couple hours in the lab, you know, so it can be a really great way to make some money while also going to school. And then we also try to get them involved in research. So it's something they may decide later on that they want to pursue, graduate education. In fact, the reason that I went to graduate school after working for a little bit was because I was reflecting on some things that I had really enjoyed during my time at Kansas State, and it was really that undergraduate research that I loved and wanted to be able to do more of in my life.

EH: Yeah, I know when, when we have, when we have school groups visit, that's always a point that we want to make, is to make sure that students know that even as a freshman, sophomore, you know, if you find a topic or a faculty member that you know interests you in what they do and how they do it, to make sure that you reach out because there are often times opportunities that may not be advertised anywhere, anything like that. But it's about making connections and letting people know that you're interested in being a part of that. So that's good to know.

MS: Yeah, absolutely. And even if there's not a paid position you can do, I don't know if it's called volunteer work, but you could also do it as part of an independent study, a side project for a course. So faculty are always so excited to hear from students that are interested in the same things that we are.

Matt: So how do you and your lab team decide what you want to investigate and how you go about it?

MS: Well, I think we start with the bigger picture. So what are we really trying to achieve? And the question is-- or the answer is clean water, right. We want to be able to access water safely. We want people across Iowa to be able to have clean water for drinking purposes. And you know, I talked about how I really love being outside and being in the environment, and that includes recreating in the water. And so I just really want other people to feel safe when they do go enjoy the beautiful resources that we have in Iowa. We also consider, you know, at Iowa State, we're a land grant institution and we really want to serve the public. And so you know, broadly, yes, we want clean water, but we do try to cater our research questions to make sure what we're doing is addressing science that benefits citizens of Iowa. So we believe in undergraduate education, but we also very much believe in educating the general public and creating, you know, a better, better life for Iowans. And so we always keep ourselves grounded in what are the questions and what is the research that can benefit our local community, as well as the global communities.

EH: So, going back to what you mentioned about tile drainage and that so many fields here in Iowa use tile drainage as a way to improve the soil quality and to improve the growth of crops, are there things that your research specifically is looking at with those tile systems in terms of mitigating pollution runoff?

MS: Yeah, absolutely. So that's one nice thing about the tile drainage systems is that it pulls that water to a single conveyance point. And so we're able to think about what ways can we treat that water before it discharges into a stream or a river? So this is called an edge of field conservation practice.

EH: When you talk about an edge of field practice, what actually is going on in terms of removing pollutants? Is there something there that the farmers include in that field or what does it look like?

MS: Yeah, yeah, absolutely. So an edge of field practice is basically placed between the cropland, so the area where the crop is going, but before the stream system. So sometimes we'll have a buffer between the crop fields and the trees or-- and the water which have trees growing. Sometimes there's just some grassland and this can be a great place to install an edge of field practice.

EH: And so what's an example? What does that look like?

MS: Yeah, so…

EH: The whole reason you're here to talk to us!

MS: I have a favorite and it is called a wood chip bioreactor. So the wood chip bioreactor is actually a very simple practice. You can see from this slide that as that water comes through the tile line, we essentially just dig a pit, fill it up with wood chips and try to run as much of that tile drainage water through those wood chips as we can. So how does this work? The wood chips are serving as a carbon source for all kinds of different microorganisms, and over time they slowly release carbon, which is a very important energy source for microorganisms. And then there are certain microbes that are able to take the nitrate-- so we talked about how nitrate moves easily from farm fields into tile drainage systems-- there's also microorganisms that can convert nitrate into nitrogen gas, which is completely harmless. And so we've designed and engineered these systems that are able to intersect that water that has a lot of nitrate in it and then use the microbial, the naturally occurring microbes to convert that nitrate into a harmless nitrogen gas. And you can see on the bottom there's a picture of what a bioreactor can look like at the edge of the field. Several students are out collecting samples. You can see some flowers. So it's an opportunity to install some prairie or prairie strips. And in this case, we have the white wells coming out of the ground-- that's where we collect our samples. A regular reactor wouldn't necessarily have much on it. You would really just see a buffer of grass or prairie grass that intersects the crop area and then the stream.

EH: So if the idea of installing a bioreactor at the edge of a field is to remove some of these contaminants, these pollutants, that then presumably wouldn't make their way into streams and rivers, I can see that there are opportunities here for impact beyond just this field, right? So what does that look like? I mean, how far does the impact of this go potentially?

MS: Yeah. And across the state of Iowa, we're trying to integrate these practices broadly. Hundreds, thousands of different practices that could be used to intercept tile drainage, to remove nitrate. We're also looking at different things that could be done in the field such as a cover crop. That’s a crop that would grow over the winter to try and promote plants taking up the nitrogen, but the fact is that our downstream waters are very much impacted by the agricultural practices across much of the upper Midwest. So locally we can see algae blooms at local waters and lakes. You may see a toxic bloom that could come into play because of different pollutants that are entering the waterway. And then much bigger picture, downstream, much further downstream into the Gulf of Mexico, there's a dead zone, and this has been tracked for many years now. But essentially there is a zone that discharges from the Gulf of Mexico and can reach as far as the Louisiana-Texas border. It's measured annually. It can be the size of Connecticut, the size of Massachusetts, just to put it into context. But it's a zone where the oxygen levels are low enough that the fish, different organisms are unable to thrive in this area. And so the water quality and the choices that we make in our land in Iowa can impact the much bigger ecosystem in the Gulf of Mexico.

Matt: So this seems like a really big deal. How are we ever going to go about solving it?

MS: Yeah, it is really complicated when you think about what we're doing here in Iowa has impacts all the way down to the Gulf of Mexico. And it's not an easy solution, but something that we do know is it's important to start at the community level. We need every single landowner thinking about water quality. So what can I do as a landowner in Iowa that could, you know, help to improve water quality across the state? And there are lots of different options. As I've kind of mentioned, you could do things in the field. You can do things at the edge of the field. There's different ways that treatment can take place downstream, such as the nitrate removal facility in Des Moines. So we have a lot of different options. There's a lot of tools that we're working to develop through research at Iowa State, and if we can come together and agree that these tools and strategies are necessary and then to provide the support and resources in order to try and get these installed as much as possible across the state.

EH: All right, well, thank you for joining us. I think this ends this second episode of Destination Biotech. Thanks to my co-host, Matt.

Matt: You're welcome!

EH: A huge thanks to our guest, Doctor Soupir.

MS: Thank you, Eric. It's great to be here, and I always enjoy the opportunity to connect with you and your team.

EH: Well, we appreciate that too. But thank you for joining us for this, for this episode. We have lots of resources and materials for classrooms and students to use on our website that will come up here in just a second on the screen. So make sure that you check those out. We've had great partnerships with Doctor Soupir and her lab group over the past few years to put those materials together. So we hope that you'll take advantage of that. Thanks for joining us this time. Next month, we'll be joined by Dr. Adina Howe, and you'll enjoy the third episode of Destination Biotech. Thank you!