Welcome everyone, it’s lovely to see all your shining faces. My name is Gina Nichols, and I’m here to present about work I’ve done as part of my dissertation for a PhD in Crop Physiology.

First, I’m going to tell you what I did. Then, I’ll tell you my motivation for doing the research I do. This is following advice from Melissa Marshall, who trains people to talk about science, and whom was recommended to me by Frank Dohleman, who some of you know.

I arrived at ISU in January 2018. On the left are my first-authored publications, and on the right my co-authored publications since I’ve arrived. I’m showing you this to tell you I have a lot of things I’ve done that I want to tell you about. But I can’t.

So I made a short list of some of the key take-aways I have from my work.

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This list is not exhaustive, but it is still too long for a presentation. So I’m going to focus on telling you about #1: the effects of longer crop rotations.

Here we go.

This is a document, that, with a slight change to the title, has a chapter I love. It was shared with me by one of my advisors, Matt Liebman, who is the Henry A Wallace Chair for Sustainable Agriculture here at ISU. That may or not be connected to why he shared it, but I hope the name Henry A Wallace sounds familiar to many of you. He is from Iowa, and was truly incredible. He was the secretary of agriculture, he could be called the inventor of hybrid corn and started Pioneer, which is now Corteva. He commissioned this report because he was concerned about the way our nation was treating our soil.

There’s a chapter that is basically an ode to crop rotation. Now remember this was in 1938, so a lot of the crop rotation benefit was fertility-based. But even today, this phenomenon holds true.

In today’s context, growing corn continuously on the same field might give you around 180 bu/ac, or roughly 9 Mg ha. If you put that field into a corn/soybean rotation, your corn yields bump up to around 200 bu/ac. Interestingly, we still don’t know why. SO that is one of the questions I sought to address during my PhD.

Now, often when I tell people I’m studying agronomy, they have no idea what that means. It’s not a word used in common vernacular, although our department is trying to make it an everyday word. They have had an ‘I’m an agronomist’ campaign going for a little while, you can actually see some posters at the Des Moines airport next time you’re there. So if you are unfamiliar with the term, here’s a definition that, if you’ve taken Dr. Ken Moore’s class you might be familiar with:

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Here is how corn responds to nitrogen. On the x-axis we have the amount of mineral nitrogen applied, and on the y-axis is corn yield. If you are growing corn in a field that was soybeans last year and you don’t put any nitrogen on it, you could expect about 7 Mg ha. Note that speaks to the amazing advnaces in genetics we’ve made, for sure. But anyways as you add more nitrogen, your corn yields go up, but they don’t go up forever. At some point they flatten out, and…

That point has a special name – the agronomically optimum nitrogen rate, or AONR. In this case the AONR is about 100 kg of N per hectare. Note that this is ignoring economics. Nitrogen costs money, and depending on the price of corn it might not be worth it to add more nitrogen. But here we are only concerned with biophysical happenings, not what the almighty dollar is worth, so just note this can be calculated in different ways. The curve for corn grown following a corn crop looks different…

There’s a lot of information here. Firstly, you can see that when you apply no nitrogen, the continuous corn yields less than the rotated corn. You can partially make up for that by applying more nitrogen, but you can also see you have to apply MORE nitrogen to get to the yield plateau in the continuous corn system. So you are applying more nitrogen, and still getting less yield…

In this instance rotated corn required about 100 kg N, and continuous corn about 225. Secondly, you’re applying more than twice the fertilizer, and are releasing all that extra nitrous oxide associated with fertilizer application, but are still achieving a lower yield. Some of my other work has also shown that if you overshoot the AONR (and most farmers aim to overshoot, which is another story), but if you overshoot the AONR in the rotated corn, your nitrate leaching doesn’t immediately skyrocket. In fact you can overshoot it by about 50 kg/ha, and be ok. In the continuous corn, your buffer is less than half that – about 20 kg N. So when we talk about using land efficiently, and with minimal environmental impact, continuous corn presents major challenges. So it’s important to understand why this is happening.

The continuous corn penalty affects a significant amount of land. Here, each black dot represents a 30 meter by 30 meter area of land that has had corn on it in the past 12 years. The orange dots represent land that has had corn on it for 2 or more consecutive years in the past 12 years. Approximately one third of all corn grown is subject to the continuous corn penalty.