Intro: 0:04
The way we grow and produce food is ever-changing, shaped by consumers and the climate in which we live and farm. Research at all points of our food system is essential for continuously improving foods journey from farm to table. The Manitoba Agriculture and Food Knowledge Exchange explores timely research, innovations and applications that make our food system better than ever. Join us for today's podcast.

Chantal Bassett: 0:28
Hello and welcome. This is ChangeMAKErs, a Manitoba Agriculture and Food Knowledge Exchange, otherwise known as MAKE podcast series with me, Chantal Bassett. In each episode, we'll chat with an academic member of the faculty of Agricultural and Food Sciences at the University of Manitoba to find out about the research innovation they're working on and how this is shaping agriculture and food production in Manitoba and around the world. Now, as the research facilitator for the faculty, I get to work with all our incredible innovators, and I think it's high time that you get to know and uncover their research and the person behind their discoveries. Today I'm joined by Dr. Marcos Cordeiro from the Department of Animal Science. Thanks for joining me, Marcos.

Marcos Cordeiro: 1:06
Thanks Chantal, glad to be here.

Chantal Bassett: 1:07
So, Marcos, before we get into the details about what you study, can you share, how you got here today?

Marcos Cordeiro: 1:12
Okay, so that's a very broad question, it can be answered in many different ways. I think it's a combination of good advice and educated guesses. You know, when I was at high school, trying to define which path to take, I know where I didn't want to go, but I was not sure specifically the path I like to follow. And I was talking to my dad about this, and he's had a good career in law. And I know I didn't want to do law, but he is passionate about agriculture and food production. So, he just, he didn't tell me to go there, but he kind of prompt me along that, "how about food"? You know, "we can do without gadgets and electronics, but we cannot do without food. So how about that"? I was thinking about this, and I also did my research on agriculture. I came across the Blue Revolution, which is aquaculture, right? Production of fish, shellfish, this kind of thing. I said, that's interesting. They had a very interesting prospect. Moving forward, I want to play safe as well, be in a field that's also going to expand. So, I look into that and I kind of like it because it's not conventional agriculture, you know, like animal production or crops. And then that piqued my interest, and I followed that. I went for fisheries engineering, which, you know, does a bunch of different fields. But one that I concentrated on was aquaculture, shrimp farming specifically, and interestingly enough, the industry was booming in Brazil when I was going through my undergrad. This was in late, the late

1900s. I won't age myself here, but, you know, late 1900s. And, uh, yeah, the industry was booming there and I was seeing this growth and when I graduated I took a job in a different state, and I found the company I was working for, they were building a new, a new facility from the ground up. So I saw from the first shovel on the ground all the way to building the product. So I saw that this was over the course of a couple of months, and I said, I can do this. You know, I think I tried it myself because industry was so promising that I want to try it. So I went, I had the technical background to do this, and I went back to my state and tried it. What I didn't have an appreciation about the environmental side and permits. So I gauged myself very... this is one of the wrong guesses I had. I felt it would be very quick. It took me two years to get that permit. So that was an eye-opening experience. So I start to, I was awakened to the environmental side of agriculture, which I didn't have a good appreciation. I waited for that permit and I, in the meanwhile, I was doing a post graduate specialization on environmental managing and planning. That's why I started to be exposed to all the intricacies of that side of agriculture. By the time the permit came out, I was building the facility, then the industry changed drastically . We... it flips like we had a problem with a disease. The currency exchange rate was not good with the dollar and most of the market was for export in Brazil. You know, the US had an anti-dumping action. Bunch of different things combined. Long story short, I decide to stop, put it on hold, and I decide to look at what to do. And then I looked at furthering my studies. I then looked at that experience and changed my goal from annual production to more sustainable... sustainability and environment. And that's where I start to look. When I got this scholarship to come to Canada, it was the Canadian bureau for CBI, Canadian Bureau for International Education. I decided not to go for aquaculture, which had been either course . And then I start to looking into environment. And then biosystems engineering had a good program here, dealing with that. And then I came, I did my master's here was on nutrient migration from feed lots. My PhD was another move into crops, which was irrigation advantage in the soil and water engineering. And then in this few years of grad school, I start dealing more of modeling. But modeling was never the main focus of my research. My research was heavily based on field research. So I didn't like to be called a modeler, you know, I just like... okay, models are something I use, but it's not my main thing. But then when I graduated, I start, you know, my first postdoc was with modeling work with a large group out of Saskatchewan. And then I moved to AAFC in Lethbridge, where I did modeling for animal systems. And this is where everything came home, right? So the modeling side, the environmental side, the animal production, this all different fields I had to work separately, came together in those years I spent in Alberta. And then that was what helped me to come to the department where I'm today with animal science, which is a little bit different than my background because I come from biosystems engineering. Now I do most of my modeling research related to animal systems, which interestingly enough is heavily related with crops, right? When I... so my modeling has a heavy component of crop modeling as well, because all the feed that goes into animal production comes from crops, right? So feed production. So I had a good coverage of all the different areas that I work with today through my journey. I don't claim that I could see that back then. You know, sometimes I felt a little bit lost, like I'm jumping too much

from area to area, but now I could see how this multidisciplinary experience that I had came together, the position I have today.

Chantal Bassett: 6:04
So in terms of, yeah, very multidisciplinary approach. And you're integrating that all into your research program today. What more can you tell us about what your group is working on?

Marcos Cordeiro: 6:13
Based on, like, as you can see, my... the modeling starts to become more and more prominent in my career... my academic career. So, I start doing much more modeling than I did in the past. So, I was expanding on that area as well in terms of different models for different tools, for different goals. If you have a toolbox, you don't use a hammer for everything. If you only have a hammer, everything looks like a nail. So, I start to learn that I need different tools to use in my research program. And my research program starts to diversify based on that. From the modeling component, I start looking into, okay, my models can only run if I have data. So, I start looking into data collection. So, some of my research or my projects have to do with field monitoring, going to the field, collecting the data. Some of my research and projects have to do with improving the tools I have. Sharpening those tools for example, some of the models I used, they were developed 34 years ago. So, they're not meant to run on fast computers that you have today. So, we have to improve those tools. How do I make this run faster? Because I'm working on a project right now with a postdoc, he just run over a million runs of one model. And you have two models in this project. So, we have to make those things run faster, otherwise just sit for weeks on end waiting for the result. One part of my research is trying to make those models run faster. And one way to do this is just having better computers. If you wanna go fast, buy a Ferrari kind of thing. We try to invest in some of the infrastructure that you have is to get better infrastructure, better computers to run those models. But then you have to make those models up to date in terms of running the infrastructure. So, it's more in the computer science kind of thing. And the other component that my research is also starting to go is on the consumer side of things, because agriculture is more influenced. I don't do socialized types of research, but I see myself collaborating more of people who do this kind of work. So, this helps to inform what I do with my model. And the last thing is, which is more or less in-line with the tools and computers, is trying to do the data analytics. Because now we have a much larger volume of data that you had before. So, to make sense of this data you need new techniques, it's like finding sometimes the need in the... so it's not as simple depending how you approach it. And there's different statistical and methodological approach that you can use for that. And my research is also expanding that direction rather than breaking away from classical models or statistical models into more, you know cutting edge type of deep learning kind of, which everyone is moving that direction. And also appreciate the challenge with those techniques. For example, if you... everyone talks about deep learning, but those models are black box models. So we don't know. They will give you... they might give you the right answer, but you don't know why, it's too

complex to look inside. So, we like to know the reasons behind the results. So sometimes have to couple those techniques and look back and just slow down and look at different techniques. So, expanding on the data analytics is also one part of my program that I've been investing in.

Chantal Bassett: 9:08
Okay. And then, you were talking a bit about field research. What kind of data points are you gathering from farmers' fields or from research, trials, organized within the university, and what is the outcome? How are you going from a certain data point? How are you combining it? What conclusion are you drawing from those data points?

Marcos Cordeiro: 9:27
So, one problem that I think I'm losing my hair over is the problem of scale, right? You mentioned data points. Sometimes one data point is not enough for us, right? What you have to do is, for example, if I measure a hydraulic conductive view of soil in one point, how does it translate across a field, right? Across whole farm, across a larger landscape? This is one of the challenges of scale that you have. And models have a lot of these, this type of data that has scales are a little bit different, thankfully. And this is, as I said before, one of the areas of the research I've been doing which is developing those data sets. So today, different than maybe one or two decades ago, when digital data sets were not available. So today we have land cover, land used, we have soil data sets, we have all sorts of data sets that are ready to download and be used. But some of them are not, don't have the quality that you need. So, we need to go back to the field and get a more refined type of data. One for example, that I work a lot with is productivity. We can guess that, but to be able to develop those models, we have to have very accurate regions of productivity for grasslands, for example crops. So, there's no other way to do this except going to the field and measuring. So, this is the hard work that we have to do. Some of the data sets are not there. For example, soil fertility, what is the biochemistry of the soil? You have to take samples and measure that. There's no way around it. We may have general values from literature or from previous research. Sometimes to get the scale we have to go there and collect some of the data.

Chantal Bassett: 10:50
So, you told us a bit of all the digital tools that you need. Some of them physical. And I understand that you secured a Canada Foundation for Innovation grant to get advanced research computing dedicated to your research program in agricultural studies. Can you tell me a bit more about what this advanced research computing is?

Marcos Cordeiro: 11:08
Sure. So, as I told you before, my models need computer power to run and I needed a large infrastructure to run my models, especially for multiple runs. So, I started the conversation of just calling people, right? Just calling people at computer accounts and say, "hey, how does it work to get some of these infrastructure". And of course, they pointed me to the traditional route, which is a competition to ask for the resource

available, get some allocation out of that. And then I start looking at the numbers in agriculture. And I saw their users, who they are, and agriculture is only 3% of their resources, right? They only have 3% of their resources, it is used by agriculture researchers, researchers in agriculture. So, I said, no, I was trying to just think why, because we have the application. The problem is we lack know-how and you don't want to make that jump. So, I make that the case. So, I needed the resource, but I was thinking beyond my program. I think there are many people that could use the resource. They need know-how. The idea behind the CFI was, and this is the case I made in the proposal, was agriculture has a huge application that needs those resources. But we need preferential access because we need to build that know-how, we need to be able to develop the application. So, we need time, we need resource allocation for that. If I am going to apply and compete for people who are used to this kind of competition, I have no chance. So, I need that kind of edge to be able to develop my program and other programs around. And actually, that was very well received by CFI. We got funded, and those resources are in place. We had a few challenges in terms of where to place those resources and everything. So technical questions, but we got through most of them. And now this infrastructure finally is being implemented, and the idea now is to start to ramp up the programs and also to advertise this at the faculty level so that people know the resource is available. I know people here in our faculty who need those resources and they can benefit from the know-how. So, the idea for us, and I have reflected a little bit on my research team, because my research team has the expertise, people who are not from computer science, but they're from engineering, they have this background, they are from environmental science, they have this background and this build, this know-how that you need here. Hopefully my program will be able to be a little bit of a nest for HQP and graduate students who come and learn a little bit of that and go develop their skills elsewhere. The way I see this is that those resources are becoming increasingly important in any research field that uses large data sets.

Chantal Bassett: 13:40

Okay. And you talked about your research focuses on enhancing the productivity and also just looking at the environmental sustainability across different agro ecosystems. And you talked about how you're relying on some existing data sets, you're having to rely on collecting some data yourself, or relying on field trial researchers to collect some of the research in trials. Are you gathering only from the soil, or is it, perhaps, are you capturing broader - the weather, weather stations and are you capturing anything in the sky?

Marcos Cordeiro: 14:10

Yes. Well, that is an interesting question. I do work with other data sets. For example, I try not to reinvent the wheel. So, if the data's there, I try not to go there, it is already doing this, right? For example, weather data is a good example. The province has a good network of weather stations, Environment Canada has a good network. Sometimes not at the right location that you want, but for the most part, for recent years, it's all there. But one particular type of equipment that we also got into was the acquisition of high-

end data, drawn with very advanced hyperspectral sensors. So that came about. Again, it's one of those moments that brings you together. Because I was thinking about going research with drones. People talk about drones, I was in a demonstration this week with farmers, and they saw the drones, you line up the drones that you have, those are nice toys. People see drones as toys, right? For us its as tools. But the thing is, I try to see, do I really need one just because everyone is using a drone and do I really need one? Again, I took that approach of looking what's not there and where things are going. There is... most of the drones you see flying today, they are, they have a specific type of sensor. I was talking to Paul Bullock from soil science. He retired recently, but we were just brainstorming this. I said, Paul, let's do something that nobody has access to because we need more information that those drones are not giving us. And so the multi-spectral sensor is not giving you need as much spectral resolution, so let's go with something higher. So we start to look into what type of sensors. It's funny because I talk to Paul, how much does it cost? He says, ah, I don't know, $20,000.00. Well, when you find the sensor, everything was said and done. Well, it was more than 10 times that, right? So that was a little bit of a surprise to us, but we knew this, we need to go that direction. And that discussion was timely because at that time, there was a large proposal being discussed at the faculty level, and we were able to make that ask in that proposal, and people see the relevancy of that particular drone. Long story short, we had the drone here. This drone is the third one in Canada. It is the first one used for agricultural research. So, the researchers of Manitoba have access to equipment that nobody else has in terms of the capability. We are now ramping up this equipment. We just went through training, it's very complex to use. It's not very simple. So that's why it's been a little bit slower. But we are able to approve some projects. And this is, the beauty of this is very much disciplinary. For example, the one project I have with the first project I have is this drone is funded by ECCC, Environment Canada. The particular branch I'm working with is for the conservation branch that uses it with birds. I know nothing about birds, right? But we have a common interest, which is grasslands. They approach grasslands from the bird's perspective. I approach grassland from the productivity of soil, from beef industry perspective. So have a common interest in grasslands. So, this is where they see the applicability of this technology to what they want to do, and they came aboard and they funded the project. So, the beauty of this is that these new technologies and new tools that you use are bringing together new partners that before were not natural partners. So, we'll be able to identify and find those players. But going back to your question, the sensor is up and running, we begin to start our data collection this fall, and this is good, just going to generate lot of new information that you didn't have access to before. For example, if you take your camera... your cell phone camera, it takes three bands of information, right? Red, blue, and green. It's three different bands that you turn into one. This sensor takes 490 pictures at once, right? So, it's a lot of information there. So, the idea is to use, hopefully, some of these bands or some of these pictures to relate to something you want to know about grassland distribution, about grassland growth or grass species of grasslands in this stand. And if you know that and you continue to monitor that, then we have a much better handle on the management of that vegetation. Not only for productivity, for the beef grazing, for example, but also from a conservation perspective. How do you manage this vegetation for ecosystem services? You know, like

carbon sequestration or the birds, for example. This is all, you know, coming together if you can monitor that different players or stakeholders have a vested interest. So, you can have a conversation that benefits more than one group.

Chantal Bassett: 18:29
Then in terms, like you talked about different scales. You mentioned landscape scale and probably down to the farm scale and perhaps other scales. And you talked about, obviously you're using some past data. So, can you give me a kind of a scope of how historical information might and current information might be informing or helping farmers predict and why would we want to predict? Aren't we growing the same things every year? Or on the news we're hearing a lot about climate change. How is that really complicating matters? Is that why we need a modeling approach?

Marcos Cordeiro: 19:03
It is. So, for example, when I was growing up, I didn't care where my food came from. I just ate. Today, consumers are much more concerned if this food is responsibly produced from a sustainable standpoint, you know, from a work standpoint. Not using child labor, for example, things like this. So, the consumer cares about this much more than they did before. And this is, so because farms are consolidating and becoming corporations, they care about this as well. And this is spilling back, going back to the farmer. So, today's farmer has much more on his plate or her plate than they did 30 years ago. They have to care about sustainability, stewardship, all those things that before were not there. So, in order to do this, and today, we also live in a moment in history that we are putting a lot of focus on science-based evidence to drive decisions that we make on the land, as well as policy making. Science is becoming a critical piece of this whole thing, of this whole production system that's becoming more complex. So, the problem of scale, each of this is before the products that you use, were not enough to manage the landscape the way you want to manage today. Because today, it's managed, for example, farmers managed landscape in large tracts of land. Let's say, or a section, for example, if you're familiar with Canadian land survey. But today we are moving into precision agriculture where I want to manage my field by zones. So, in this zone, I may apply more fertilizer in this zone, I may pull back a little bit because this zone is not as productive. So, in order to manage my landscape this way, I need way more finer resolution information. One example is soil, right? Sometimes you have one soil classification that's very coarse, so it can, it might take, classify an entire coarse section as one soil type. But now you, if you go to a more refined, with a more detailed soil survey, you might find that, no, this quarter section has in fact four different types of soil that I now need to classify. And now my management decisions are based on those four different types of soils rather than the coarse one that I had before. For my models to give proper answers to those questions, I need to know at this level of resolution because I'm might just be in the ballpark. But if I want to manage those landscapes very precisely from a precision agriculture perspective, I need to know this precise information. So, this is one type of information that can use heat maps. Also, another one is fertility programs, another one is variable rate application of fertilizers. Our models

help to inform those decisions. We don't need to go and try all these things out in the field, which is very expensive and time consuming. I can do this inside the models, see what the models tell, and then I can say, okay, this is interesting. What about if I try this to see if the model is really correct here? So, I can just select some of the outputs that the model or answers that my model gave me and apply them to the fields. So, all of a sudden, I narrow down from maybe 10 different management decisions I had to make, to maybe the two most promising ones. So this is cutting costs and also it's expediting the way, because if I were to try different management decisions, I probably need 10 fields, or if I need to replicate any more , if I need much more 10 years, for example, if I only have access to one field, the models can give me this in just a matter of weeks or months, and then I can try it in next growing season. Is what the models really telling, is anything I was not aware of? Is that something that the model is missing? This is a circular process where I use my models, I go back to the field to validate that if it didn't work, what was wrong? Was it an assumption I made, or some data is missing? The bottom line is I can help farmers and policy makers to define management decisions much quicker with models than I was in the past with traditional monitoring of that huge scale.

Chantal Bassett: 22:39
And are farmers able to access your models or other, are there any commercial models out there? Is your research informing those models? Or is it more that you can draw conclusions from the models that you are working with to inform policy? What's the end goal of what you are generating and for which users?

Marcos Cordeiro: 22:59
Sometimes these models are more complex than the average farmer would be able to use. So, what we try to do in this case there to, is to come up with decision support systems. We have the outputs, but we try to summarize them in an interface that's much easier for the farmer to access. So, we run the model in the background, all the, you know, intricacies of that the model entails, but then we try to portray the results to the farm in a much simpler way, in a way that makes sense to them, right? The language you use, you don't go about parameters and, you know, technical definitions, you go more like a, what's something that farmers would understand and have the access and try to explain that in terms of management decisions more for the most part, right? A good example of a model like this, which is made for farmers is the HOLOS model by AgriFood Canada where the, you know, it's, they have a simpler interface that farmers can use. They have a more complex version as well. But the idea is if you can have a decision support system that, that farmers can access online and have access to this, if I tried this, what would happen to my emissions? For example, carbon emissions and things like this, right? In a way they can understand. So, we have to simplify things along the way. Another example I could give you is in terms of, we for example, have some projects with, with dairy production, where we use camera technology to try to, to come up with decision, management decisions. Those cameras, they generate a lot of data in the day, but for us, the goal is to boil this down and to change it into one number or two that

makes sense to the farmers, right? So that animal needs attention, the productivity of that animal is going to drop, you know, is in decline or is going to drop in a couple of days, if you don't watch this. This is the type of formation that you want to provide the farmers. Not only very complex pictures that he has to look at, it's just one number actionable piece of information that he can make use of.

Chantal Bassett: 24:44
Marcos, what is the most interesting or surprising thing that you've discovered so far?

Marcos Cordeiro: 24:49
It's an interesting question, you know Chantal I have been expanding my research, the scope of my research, I think the most interesting things have been those I didn't pay much attention to. But at the end of the day, they became critical to my work. Grasslands is one of them because I came, as I told you, from a different angle. From crop production and things move much faster in the annual production system. I just felt grasslands as being that monotonous, consistent unchanging landscape. That's part of what I did. But I never spent too much time with grasslands. Since I took this position, I started looking much closer at grasslands and just see how complex, dynamic and how important they are to what you do. Like those landscape, they are one of the biggest carbon storage that you have. And the role that farmers have in maintaining those landscapes. If the beef industry is not there, for example, those landscapes would be under much higher pressure to be converted to annual cropping systems. So, if that we lose biodiversity, we lose carbon sequestration, we lose all the ecosystem services. So, for me, it was an eye-opening experience to have a closer look at grasslands, something that at a distance didn't look as dynamic. It's very dynamic, very complex and important. So, this was one a very interesting surprise I had.

Chantal Bassett: 26:06
So, Marcos, what's one aspect that has influenced your research program?

Marcos Cordeiro: 26:10
Okay Chantal, one thing that I can speak to is the importance of collaboration in the work I do, I've always worked with collaborative teams. My teams were all always large teams, and I was just doing one component of a larger project, and it has been very formative for me in the way I approach research. I collaborate with people from Agrifood Canada in Lethbridge. And I worked with Tim McAllister, and he managed large teams of many, many people. And one thing that I saw is the approach he used for research. I know he brings people in; he values their input to research. And once he told me that he's much more productive because of his collaborations. There's only so much you can do by yourself, but you can do so much more if you collaborate with people and you can do different things. So, this is one thing that I actually kept with me, and I try to implement. And today I collaborate withwith people across Canada from coast to coast, literally, this has been really helpful for my research. Another example I could mention is Kim Ominski from my department as well, she's very generous with her time in terms of

coaching people, especially young researchers like us. And I've seen the way she conducts herself in research, in collaborations, it is very helpful for me to model my program after her. So, collaboration is one thing that I cannot minimize in terms of the importance for the work I do, especially because my research is, which is interdisciplinary, right? So, I may not know as much about beef production, but then if I bring the right person in, then that complements the skill set that I need to develop some projects. So, this is one example of how this multidisciplinary collaborative environment has been helpful, especially for the generation of new ideas as well. So, it's much more fertile in that sense, that you talk to different people from different backgrounds to come up with new ideas or to come up with solutions for problems as opposed to working by yourself, locked in your office. It works really well for me.

Chantal Bassett: 28:04
So, Marcos, can you tell us something about yourself that's unrelated to your research?

Marcos Cordeiro: 28:08
Wow... I am a simple person. You know, I don't have a very fancy lifestyle, and I feel like I keep... I'm a home person. I like to be home. And I always been something maybe because I was telling Kim Ominski the other day about... I'm an introvert person. She said, really? I cannot tell this right? But I said I had to train really hard to get myself out of my shell, but if I could choose, I would spend myself and I spend my time quietly. And I have always liked reading and music. Music is something that I got into a little later. It's such an effective activity for me to get my brain out of this working mode, this is how I get to unplug. Yeah, and not only listening, but I like to study it, maybe because I come from engineering, but I like all the math behind music so predictable in terms of intervals and things like this. But I do study music and something that... one genre I like is jazz. Not because I play it well, but because it makes you think. They say that jazz music makes you think because your brain is constantly tuning, what's the next interval? Hey, it doesn't make sense, I expected this. But from here, I like jazz and looking at those things. And something that I got later on, after I started music was the technical stuff, all these mics I see here. And I was talking to the tech guy before we started here, oh, let me see your interface. Mics and stuff like that, you know, so I like this technical stuff. It's a bit, you know, geeky too, like, you know, technological goes back to technology. I like this stuff. This is something that is really effective in terms of helping me to unplug a little bit and remove myself from work and from research and teaching, because our line of work is very tempting in terms of, we can work forever I am always having new ideas and the brain gets used to that and always thinking, what about the next research question or the next project? How can I use this? Going back to something that takes my brain out of that helps a lot. And the funny part is that once you have that break, sometimes you have that idea for research. It comes up, hey, I never thought about this. You know, just unplugging, taking some distance. Taking some distance from your subject helps you when you come back have a fresher perspective to it. So, in a short answer, yes, music does help you with that.

Chantal Bassett: 30:18
Cool. Do you have any recommendations, best artists to recommend?

Marcos Cordeiro: 30:21
Oh, Joe Pass, guitar. Yes, for sure.

Chantal Bassett: 30:24
Thanks so much for chatting with me, Marcos.

Marcos Cordeiro: 30:26
Thanks Chantal.

Chantal Bassett: 30:26
This has been Dr. Chantal Bassett, joined by Dr. Marcos Cordeiro from the Department of Animal Science at the University of Manitoba. And that's it for today's episode of ChangeMAKErs, the Faculty of Agricultural and Food Sciences research and innovation podcast. Join me in future episodes to hear about other fascinating research being led by agricultural and agri-food innovators at the University of Manitoba.