Abby Morrison: Hello, and welcome to Field Lab Earth, the podcast that's all about past and present advances in the fields of agronomic, crop, soil and environmental sciences. Today, we'll be talking to Dr. Gabriel Nuto Nobrega about his paper "Diffuse Reflectance Spectroscopy (Vis-Nir-Swir) as a Promising Tool for Blue Carbon Quantification in Mangrove Soils: A Case of Study in Tropical Semiarid Climatic Conditions", published in the Soil Science of America Journal.

I'm your host, Abby Morrison. Let's talk about science.

Hi, Gabriel. Welcome to the show. How are you doing today?

Gabriel Nobrega: Hi. I'm very fine. I'm very excited to just talk about mangroves.

Abby Morrison: Me too. Welcome to the show. So, why don't we start, and you can just tell me a little about yourself, kind of about your background and how you got to your science.

Gabriel Nobrega: Okay. My name is Gabriel Nuto Nobrega. I'm from Brazil, from a city in the northeast of Brazil. It's called Fortaleza. I have my undergrad course and my Masters, I got there in agronomy. So, I'm an agronomist, and last year I obtained my PhD level at the University of Sao Paulo in Piracicaba, Brazil. Since my undergrad course I started working with mangrove soils with professor [inaudible 00:01:45] as a coordinator and professor [inaudible 00:01:49] from Santiago de Compostela as a coordinator.

Despite being an agronomist, which is a profession that is most focused on agriculture, but I think the status that I took from my university helped me a lot to study coastal wetlands. So, this is my background.

Abby Morrison: Sure, and we're talking about blue carbon and diffuse reflectance spectroscopy today. Can you tell me a little bit more about both of those?

Gabriel Nobrega: Since I started reading and studying mangroves, I got fascinated by this ecosystem. The beginning of 2000s, like I think 2007, mangroves got highlighted by some importance as a globally significant blue carbon sinks, which means that these ecosystems are very capable to sequester carbon, to take carbon from the atmosphere and restore on the soil. But there's a problem for the quantification of the carbon stored in mangrove soils.

Since mangroves are often flooded soils from the tidal, the soils have particular characteristics, that the commonly used method is not appropriate manner. The commonly used methods for quantification of carbon in mangrove soils ... They normally overestimate the carbon content, which is not adequate.

So we started thinking which methods could be used to quantify carbon in mangrove soils. Then they started using diffuse reflectance spectroscopy, which is a technique that we put a light in our sample, and use a spectrometer which is
a device that captures the light that reflects from the sample. And using the
cues that we obtain from this light, we can quantify carbon. So, it's much more
easier. It's a cleaner way to quantify carbon. It's much more cheap than the
other ways.

Also, it doesn't have the problems that the chemical methods for carbon
quantification have. So, it's been a very promising tool. I just must say that
diffuse reflectance spectroscopy is being used for soil science ... have been used
during the last, I think, 1 years. So, we tried to adapt this technique for coastal
wetland soils and mangroves.

Abby Morrison: Sure. So, can you tell me some of the problems with the more traditional
methods? Like, why don't they work on mangrove soils, as opposed to other
soils?

Gabriel Nobrega: Sure. I'm going to try and speak in a more comprehensible way, I think. In
terrestrial soils, like soils that are not flooded, the micro-organisms [inaudible 00:05:12]use oxygen for their respiration, to obtain energy. When we have
flooded conditions this kind of respiration doesn't work. So, the micro-
organisms must use another component to breathe and to obtain energy.

So, in flooded soils they started using some nitrate, some iron, some
manganese, and some sulfate, which is very abundant in mangrove soils. The
problem is, with these metabolic pathways, with these respiration pathways,
some reduced compounds, that we say, are produced. So, when you try to
quantify carbon we measure something else, then carbon. So, that's the major
problem for the quantification itself. But when you start thinking that, for this
carbon configuration, use stronger acids, start using strong oxidizers, we
generate a lot of residue which is very toxic. We use chromium, which is a toxic
matter. So, this isn't a desired advantage of chemically carbon quantification.

Abby Morrison: Sure. So, you had a good analogy to describe diffuse reflectance spectroscopy,
which I am going to call DRS from now on, because it's very hard for me to say
for some reason. So, can you tell me an easy way to understand what that
technology does?

Gabriel Nobrega: Sure. The diffuse reflectance spectroscopy, or DRS ... It's a method, it's a
technique, that works basically as we see the world. In our world we have a big
lab, which is the sun, that emits light. The light travels through the universe and
interacts with the object. The objects are then reflected to our eye, and that's
how we see the things. For example, a flower.

For the diffuse reflectance spectroscopy is the same thing, but instead of using
this natural light, we use specific light in a dark room, that we light our samples
and then collect the light that is reflected by the sample. And using this light we
can quantify some properties of the object. For example, carbon.
Abby Morrison: Excellent. Okay, so we have this environment, mangrove forest. Can you tell me a little bit what that looks like?

Gabriel Nobrega: Sure. Mangroves is a typically tropical ecosystem that extend from the tropical regions of all over the globe, and it's basically made of trees that are adapted to the tidal fluctuation, and the salinity fluctuation that occurs. For mangrove soil are in that coastal zone, that the sea water rises and floods those fields, and then when the tide returns to its lower levels, it increases the salinity on those areas, and just, mangroves are able to [inaudible 00:08:55] those sides.

They're commonly sticky soils with a lot of carbon, and some animals that are adapted to live with those trees, for example crabs, some birds ... Due to the fact that mangroves are located in transitional zones from the dry plain areas into the ocean, provides a lot of ecological function. For example, mangroves are very important to act as a nursery for birds, for fish, for mammals like [inaudible 00:09:38] and some [inaudible 00:09:39] as well.

So, in summary I could say that mangroves are one of the most important forests in the world, which are basically made by trees, and they are adapted to [inaudible 00:09:58] with a wide salinity range in flooded soils and those reducing conditions that are characteristics of these ecosystems.

Abby Morrison: Great. So, you had these forests, and you wanted to see if DRS would be able to correctly gauge how much carbon is in them? So let's move on to kind of how you did that. Can you tell me how you went and gathered your samples, what you were looking for in a sample. Anything like that?

Gabriel Nobrega: Okay. During my Masters I started working with carbon quantification in mangroves. The main focus of my own work was to understand how carbon dynamics occur in semiarid mangroves. So, for those samples that I took for our study, we sampled in three different mangroves, the Sierra Coast, which is a stage from Brazil. Then we sampled in range mangroves. We established some sample points with ... We tried to take points at the same physiographic conditions. Most of those sites were based on the same tree species. And then we collected samples using a sampler, which is a stainless steel tube, pipe, that we'd insert another pipe inside to take the samples.

We'd take the same test tube pipe we'd insert into the soil. Then we'd take some pvc tubes, put it inside, close it, and take the samples. I can say one thing, that it's not very easy to work in those mangroves. We've got some friends that got a little bit stuck.

Abby Morrison: Oh no ...

Gabriel Nobrega: Yes. The mangrove soils are a little bit sticky, and it's not as hard as the common soils, so sometimes it can get a little bit sticky, but it's part of the work. Then by the end of the day it's a lot of fun that we have there. It's like we're looking
always for the most protected mangrove area, so we have a lot of beautiful sights to sample.

Abby Morrison: Sure.

Gabriel Nobrega: So, it's a good experience to see some good preserved areas and some things that are not common for everybody. Not everybody has the opportunity to see such beautiful forests as mangroves ...

Abby Morrison: Yeah.

Gabriel Nobrega: ... so it's a very pleasure. And also, sometimes when we are sampling, we can see some manatees. I've seen a lot of turtles. We see a lot of crabs. So, it's always fun to see the nature, how it works and how beautiful it is.


Gabriel Nobrega: It's really beautiful.

Abby Morrison: So, once you got your samples, how did you transport those? I mean, is it something like sand art, or like a soil profile like if you shake it up you're going to ruin it? Or does it not matter?

Gabriel Nobrega: Yeah. As we're collecting pvc tubes, we have some caps that we close those pvcs. We put those samples in refrigerated box because we are also interested to comprehend how the reduced compounds drives carbon dynamics.

We put the samples in a refrigerated box, transport them in a vertical position. First you have to be sure one is the upper side, in the deeper samples. So, that's how we have to do. The problem is, sometimes, we have to put the samples in an insulated box inside the mangroves. So, we have to carry all our stuff inside the mangrove to make the sample ... but an insulated box and have to transfer, sometimes by boat, sometimes by walking.

Abby Morrison: Wow.

Gabriel Nobrega: And it's probably the hardest part of the job.

Abby Morrison: Sure.

Gabriel Nobrega: Then, when we go to the lab, we take out our samples from the pvc tubes, using a device like a syringe. We insert a smaller pvc inside the tube to take the samples from the pvc. We take some samples that we freeze for other analysis. And for carbon quantification we dry the samples. We remove any organic carbon that might be from salt precipitation or from shells. Then, we quantify carbon by elemental analyzer.
For reflectance spectroscopy we just need to dry the samples, grind it a little bit to make it more homogeneous, and then we analyze.

Abby Morrison: So, each of these samples, are you checking by how much carbon is in ... I don't know ... the top foot, or however much distance, and then how much is in the lower? Or is it just ... it doesn't matter?

Gabriel Nobrega: For the DRS study, for us, it doesn't really matter. We just measure for those soil layers because we also would like to characterize the areas.

Abby Morrison: Sure.

Gabriel Nobrega: We took three very different sites to see the wide range of the carbon contents from the semiarid mangrove soils. So, that's why we took samples from different labs, but it's just because to take a better representation for our mangroves.

Abby Morrison: Okay. So then, what did you find? Did it work as you'd hoped? Were there any surprises?

Gabriel Nobrega: Yeah. In fact, it worked really well. We got some statistical model that showed that it's a very promising tool. Also, there's the opportunity to use reflectance spectroscopy to check the other characteristics of mangrove soils. And in probably a half day of working and taking those light spectrum ... we'd do like a hundred of samples .... which we are not able to do using chemically methods. So, it's a much faster way to quantify carbon.

Abby Morrison: Yeah.

Gabriel Nobrega: It's a much more easier way.

Abby Morrison: Well that's great. Congratulations.

Gabriel Nobrega: Thank you.

Abby Morrison: So, tell me what some of the practical implications of this research ... Where else can other scientists use this, and why is it so crucial that research like this is being done?

Gabriel Nobrega: Okay. So, as I said, since mangroves have been highlighted by its ability to sequester carbon, to store carbon amid soils, some promises have been made in order to give money for those who protect mangroves, and restore mangroves. So, in restoration practice for mangroves, one of the crucial things to ... for example, carbon credits, which is a money that you can get for carbon sequestration, you must quantify the carbon stocks in adequate way.
So, as we are getting faster in a very adequate method for carbon quantification, the management of these restored areas, and implementation of restoration programs for mangrove soils is going to be much easier. It's going to be cheaper because you're going to have to use less money to [inaudible 00:18:39] your carbon stocks without producing toxic waste.

Abby Morrison: Sure. And what kind of research is your team looking to do after this? What's on the horizon for you?

Gabriel Nobrega: So, our research group has been studying coastal wetlands for at least ten years now. We've been studying mangroves, which is most of our work, but we've also been studying hypersaline tidal flats, sea grass meadows, salt marshes, coastal wetlands, and now those coastal wetlands to better understand the cycle of the elements in these ecosystems.

Most recently we started working with mangrove recovery [inaudible 00:19:45], with mangroves reforestation. People are getting now with the importance of mangroves, and starting to replant those forests. And one of my research products that is now going on, is to identify and to quantify the dynamic of this process with replanting mangroves. So we want to see for how long we must take care of replanting mangroves, to see that they are now stable and well-developed forests.

So we can ... with this true information, a better way to quantify carbon in the time that is necessary to the re-establishment of mangroves. We think that it's going to be a great move forward for mangrove science and for mangrove protection, since we can measure better, the efforts for mangrove reforestation.

Abby Morrison: Sure. Alright. I have three questions left for you. First question: If people want to learn more about blue carbon and carbon sequestration, where can they go?

Gabriel Nobrega: Sure. There's a lot of nice and very beautiful websites on the internet that you can find a lot of valuable information about blue carbon, blue carbon sinks, and others. There's a very beautiful website which is "thebluecarboninitiative.org", and there's also the blue carbon portal, which is "bluecarbonportal.org."

Also, on the internet, there's a lot of web books, or eBooks that you can take for all the people. There are a lot of books for children. There are a lot of books for people who are not very familiar with biogel chemistry, but they can have very nice information.

If you want some information about our research group, you can go to [inaudible 00:22:11] and look for [inaudible 00:22:16], which is me. You can go to look to see [inaudible 00:22:21] underlying [inaudible 00:22:24]. Also, there is [inaudible 00:22:30] and the [inaudible 00:22:30] under 90 iche, I-C-H-E, which are some of the researchers from our study group.
Also, you can see the website of our department, which is soil science department from the University of Sao Paulo.

Abby Morrison: Perfect. We'll include links to all those on our show notes as well.

Gabriel Nobrega: Okay.

Abby Morrison: And then, second question is: If people are interested in kind of some of these topics ... carbon sequestration, mangrove restoration ... What steps can they take to get involved in that process, or kind of help with some of those issues?

Gabriel Nobrega: For those people who are interested to help blue carbon initiative, then coastal wetlands protection, I could say that there are a lot of non-governmental organizations that protects coastal habitats. Also, we have some museums in Brazil that are basically directed to those ecosystems, as we have some mangrove museums here.

But also, I think it's an important thing to say, is that we must also think about our acts with waste and consumption, since as you are looking, a lot of the garbage that we throw away are most likely to go to the sea, and then return to mangroves, and to any other coastal wetland as well. So, I think that's something that we must do. Also, maybe join one of those non-governmental organizations.

Abby Morrison: Sure. Yeah. Did you see a lot of waste items as you were going out to collect your samples?

Gabriel Nobrega: Yeah. Unfortunately it's been very common when we're going to take some samples from mangroves, also from sea grass. We see a lot of plastics, so it's important to aware people from these huge problems, and these globally spread plastics.

Abby Morrison: Yeah. Yeah, they're a big problem. So, final question for you. So, this is kind of the fun question. I mean, they're all fun questions, but: What is one fun fact about you that people would not know if all they had was your research?

Gabriel Nobrega: About me?

Abby Morrison: Yeah.

Gabriel Nobrega: That's a tricky one. So, at the most things that I like to do are always linked to the oceans and the coastal zones. I think that's why I love mangroves and other coastal wetlands, because since a kid I started to go traveling to the beach. I learned how to surf, to spend more time on the ocean. I learned how to windsurf. I love to travel to do some snorkeling and some scuba diving. So, I would say that I'm a person very close to the ocean, despite being an agronomist, and learned how to cultivate [inaudible 00:26:07]. I'd say that's ...
Abby Morrison: Alright. Well, thank you so much for your time Gabriel. I really appreciate you taking some time out of your day to be on the show. It's been so fun to talk to you.

Gabriel Nobrega: It's a pleasure to be here talking with you and to those who are listening, and I hope I could help to the protection of those sites, and to show to the audience that we can do a lot of good science outside the chemical lab, and to enjoy the nature as we are doing some research. It's one of the best things we can do.

Abby Morrison: Yeah, for sure. Well thank you.

Gabriel Nobrega: You are welcome.