Benefits and Costs of Natural Climate - Part 1 Ag

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Test. Test. Good afternoon everyone. We'll get started in just a few minutes.
[Captioner standing by]
Good afternoon. Welcome to today's webinar entitled benefits and costs of Maine's natural climate solutions part one, agriculture. I am a natural resources specialist for the natural resources conservation services East national technology support Center and I will be your host.
We will get started with the presentation in just a moment. First, few logistical items. This webinar is being recorded. All participants joining are in listen only mode and all audio is broadcasted through your device's speakers. Computer or mobile device that can help you with your audio quality and volume. We still want you to participate in today's webinar, so please type your questions or comments into the Q&A pod. You can submit your questions or comments throughout the presentation, however questions will be answered at the end. If you're having audio challenges, let there be no captioning link provided in the today's link pods. The captions open in a new browser window where you can follow along with our presenters comments. In the today's handout pod, you will find a copy of today's presentation that you can download. [Indiscernible - muffled] to the right of help in the Adobe Connect menubar. All green indicates your network connected strong by orange or red indicates a weak connection. For best webinar viewing you will need a strong connection. If you wish to make adjustments to your viewable webinar, you can make them using the actions in the screen share window. If you choose to view the presentation in full-screen mode, you will need to hover your cursor at the top of your window to see the option to return to normal view. You will need to be in normal view to see the Q&A pod so you can type in your questions. Today's webinar offers certified crop advisers continuing education units. Turn CEU's, at the conclusion, you step two in your open conservation webinars.net web a window to take a brief test, enter your certification credentials and receive your certificate by email. We will submit a five year certified CEU's on your behalf in about 30 days. Please submit your conservation planner CEU's as you need. We encourage all participants to complete the webinar using the step through process. Completing the webinar provides an opportunity to rate it using a five-star system and you can submit optional comments that are helpful to our webinar program. When Reading the webinar please focus on the technical training provided by today's presentation and what you learned by participating. The on-demand recording of today's webinar will be available [Indiscernible - muffled] at the science and technology training library by early next week.
I want to take a moment to remind participants that the use of trade names during any of our webinars is for information purposes only. Mention of a trade name does not constitute guarantee of the product that the U.S. Department of Agriculture, nor does it imply endorsement by the department or the national resources conservation service. With that, we will now begin.
I'm pleased to announce that arm moderator will take over. Works with USDA Forest Service North -- Northern research station and is coordinator of the USDA Northeast climate hub. Aaron, you may now begin.
Thanks, Jennifer. Welcome to the Northeast climate health webinar series. Thank you all for joining us. As Jennifer said, I am Erin Lane. I work as coordinator for the Northeast hub. As I'm getting started, we have some poles for you. We want to know a little bit about who you are and where you are from. When those polls pop up, kindly fill them out while I'm giving an introduction. Where are you? What is your profession?
The USDA climate hubs are a national network created as a collaboration of USDA agencies working in partnership with other federal, state, local governments, land grant institutions and private organizations. The Northeast hub covers 12 states from Maine to West Virginia and includes DC. Our mission with the USDA Northeast climate hub is to develop and deliver science-based knowledge of tactical information on climate adaptation and mitigation for farmers and land managers. With the aim to support decision-making related to the impacts of climate change. We are a partner collaborator with the University of Maine and this natural climate solution initiative project. Which is why we've invited these presenters here today. This is going to be part one of a two part series. Today, we discussed benefits and costs of Maine's natural climate solutions. This is part one, agriculture. Tomorrow, at the same time, presenters will address benefits and costs of Maine's natural climate solutions, but with a focus on forestry. The USDA Northeast climate hub has a series of webinars which I hope you will find informative. You can find them among other valuable webinars at the website. If you have any questions, while the presenters are speaking, please type them into the Q&A box. I'll monitor these and we will leave them out at the end if there is time.
Today, we have Dr. Adam Daigneault and Dr. Sonja Birthisel presenting benefits and costs of Maine's natural climate solutions. Now, I'll introduce our presenters. Dr. Adam Daigneault is with the University of Maine's school of Forest resources. He's an assistant professor of forest policy and economics. His talent

seems to be turning farms and forests into numbers and coming up with ways to analyze how changes in management can improve environmental, social, and economic outcomes. Adam is also a runner, a biker, and a skier. He says the leader of this fantastic project, which readily has piqued the interest of the USDA Northeast climate hub, and we think you will enjoy learning about it too. Dr. Sonja Birthisel is an Agro ecologist. Educator, community organizer, and we think she's a very talented researcher. She is based in Orono, Maine, where she wears many hats including serving as the director of The Wilson Center at the University of Maine. Sonja holds a VA in biology from Luther College and also an MS and PhD in ecology and environmental sciences from the University of Maine. Sonja has worked with climate hubs before. When she was in graduate school, she co-coordinated the pilot graduate climate adaptation partners program. It was hugely successful program led by the USDA Northeast climate hub. She spends her free time attempting to mitigate climate change and dances the tango. All right, well, welcome Adam and Sonia. We are excited to learn what you have to share with us today. It's now time for the presentation. Take it away.

All right, thank you Erin, and Jen, thanks to everyone who is on the line out there wherever you might be. We are particularly excited to get this two part webinar out over the next couple days. One reason I'm particularly excited that we've given sort of similar talks before. They've all been sort of centered around stakeholders within the state of Maine. What I'm seeing in terms of where people are coming to today's webinar from, Maine is in the minority. That is fantastic. Most of you are coming from outside of the New England area and even the Northeast. That is fantastic. We are definitely going to keep sort of a northern, Northeast New England lands on this, but a lot of these sort of issues that we are going to address in the general overview of what our natural common solutions really apply to anywhere throughout the U.S. and even around the globe. Thanks to Erin also just for that those kind introductions and kind remarks. It has been great to work with the climate hub. They have been a great, fantastic partner. Not just liking us to sort of outreach events like this, but also providing a lot of input along the way on sort of various aspects of this research. So, with that Sonja and I are going to sort of do this as a tagteam. I'm going to basically, you will probably get deduced as we talk with our certain expertise lies. Also just a way just to mix it up so that one of us doesn't drone on too much. With that, here we go.

So, you might have been hearing over the last couple years this idea of natural climate solutions. What exactly are those? By definition, they are really any action that conserves, restores, or improves the user management of forest, wetlands, grasslands and agricultural lands, while simultaneously increasing carbon storage or avoiding greenhouse gases. So, the term of natural climate solutions is kind of come about in the last five years, but really, farmers, foresters and landowners have been think about how to implement natural clients most for several decades. It's sort of a new buzzword for a relatively old term. Coming more and more to the forefront as states, regions, colors and international we attempt to come up with ways to mitigate climate change. Understanding how we can use nature to help achieve those goals.

Globally, natural climate solutions are expected to contribute to at least 20% of the Paris agreement aggregate reduction target. In this figure, it is pointing to essentially as sort of a mission is continue to grow over time absent of any sort of policy or mitigation intervention. You can see that carbon emissions are going to continue to grow, and therefore the threat associated with climate change will increase as well. However, this idea that we have that in order to sort of achieve temperatures that are less than two degrees Celsius above sort of preindustrial levels, we need to implement this wedge of mitigation which are basically opportunities for us to reduce fossil fuel based greenhouse gas emissions or reduce emissions from agriculture or increase sequestration from our forests and farms. That's where the natural climate solutions aspect comes into play.

In the U.S., some recent analyses has come up with that nature has a ability to remove about 21% of all the pollution. That's equivalent to removing emissions from all cars and trucks off the road, and then some. Roughly about 50% plus of the emissions reduction is expected to come from force. Probably close to 30% is still expected to come from improved agricultural practices. That's what we're going to focus on today. This idea basically where our emissions are coming from in terms of agricultural and forestry, they really depend on where and what you measure. At the global level, we also hear about issues with deforestation, livestock methane, contributing a lot to sort of our greenhouse gas emissions footprint. Roughly about 24% of global emissions are coming from what we call the agriculture, forestry and other land-use sector. Within the U.S., agriculture produces about 9% of the total emissions. That are coming from agriculture. In Maine, it's a relatively high force did state, relatively low agricultural state. The agriculture that is conducted in Maine is relatively low in intensity. We don't have a lot of high animal numbers. The amount of methane and nitrous oxide that is being produced is relatively low. You can think about different solutions that you might use to target global versus the U.S. versus Maine could differ. Based on just sort of the sweet of land uses that are currently out there and the opportunities that might arise. In addition, Maine has actually seen about a 3% drop in agricultural greenhouse gas emissions since 2004. They were already sort of on that pathway to

reducing emissions in this sector. Not only is it a relatively small sector, but it sort of already on the pathway to reducing emissions, absent of any sort of really major state or federal level policy to do so. All right, in addition to that, Maine is also seen about a 34% reduction in growth greenhouse emissions. A lot of that can be attributed to Maine being part of the regional greenhouse gas initiative which targets electric based greenhouse gas emissions.

In addition, the state has recently set out a couple of important goals in terms of how to reduce its omissions. First, it has a goal of -- That was edited through legislation to reduce greenhouse gas emissions by 45% below 19 levels by 2030. In addition to removing emissions by 80%, by 2050. When we talk about growth emissions, this really excludes any, so this is basically emissions coming out of tailpipes. Bits that are created by animals. Largely from fossil fuels and the transportation and electricity sector. It is not looking at sort of the contribution of emissions reductions that can come from forest and agriculture. All right, so with that in 2019, Governor Janet Mills in a speech to the U.N. also released, coincided with an executive order that said that Maine also has a goal of being carbon neutral, or carbon zero by 2045. That means the growth emissions, less the additional sequestration that we can get in our farms and forest, have it such that total emissions in terms of growth less that sequestration are at zero by 2045.

Now I'm going to pass it over to Sonja to think about some ways that we can actually consider think about achieving some of those goals within the agriculture sector.

Well, hello everyone. So, on the world wide scale, folks have been think about natural climate solutions in agriculture for some time. They have proposed and measured the impacts of things like cover crops and conservation tillage and crop rotations and strategic compost amendments. Along with things like grassland restoration, incorporation of legumes into pastures. Grazing optimization. As natural climate solutions. Then, there has been for many years also research on biochar, which I would say is still very much in the emerging practice category in terms of how much is used around here. Some recent research on deep soil inversion as a potential natural climate solution as well. But, our purpose today is certainly to focus in on our neck of the woods here in Maine. Globally these are some things folks have considered. I'm going to skip ahead to think about how do we, here in Maine, start estimating natural climate solutions mitigation benefits and costs if we are trying to do so on a state-by-state basis? Really drill into what is practical and applicable on a smaller spatial scale that has been studied widely in the past. To start with, we need to define a baseline or business as usual scenario. That includes looking at current policies and practices. What are people currently doing? Being strategic about drawing geographic boundaries. Are we look at things by county level? What's the timescale at which we study these things? We need to establish a list of acceptable or appropriate natural climate solutions or mitigation practices. So, not all of the practices that I mentioned on that last slide are necessarily applicable to Maine. As a team, some of the initial prep work we did was debating about what kinds of strategies should be included in a study of Maine. What was going to be applicable to growers in our region. Then, what measurements monitoring and verification has been done for some of these practices already. Is there locally applicable data that we can draw on that is relevant to our soils and our climatic conditions? Then, also be thinking kind of with a big picture lens about how permanent is the mitigation we get from these strategies? Are there ways that they are synergistic, should we be thinking about leakage? Those kinds of questions. Then, of course we get into the weeds, and this is really more Adams department with the economics of estimating the costs and effectiveness of implementing practices. This is typically done with a suite of models and assumptions. In our study we are using a mix of both economic and biophysical modeling approaches and we are trying -- We are attempting to really base that in real data to the fullest extent possible. Real data that is as applicable to a Maine contract as possible. It can be complicated to get real data for everything that we want to study sometimes. We also, in this study, have tried to look at barriers to adoption of natural climate solutions practices in addition to costs. We have done this by conducting some focus groups with stakeholders to learn more about their perspective on this natural climate solutions that we identify that were applicable. We'll give you a sneak peek of our focus group results at the end.

So, we started off -- Conceptually, this is the big picture of what we are trying to do here. We are estimating the costs and benefits of applying several natural climate solutions that we've identified as relevant to Maine, and those costs are in terms of capital and equipment. It includes labor, maintenance, and the opportunity costs. So, say you apply a new practice, reduced tillage. Might there be a cost in terms of yield reduction, or in terms of your flammable area if your cover cropping one year for example? Also, looking at examples of these practices. In many cases natural climate solutions can actually yield improvements. And cost savings. In addition to reducing greenhouse gases and contributing to carbon sequestration, and also having a host of other environmental co-benefits such as improving water quality. Or, providing habitat.

Passing this back to Adam.

Okay. All right. Sonja did a nice job outlining that. It also looks kind of wordy in theory. As Erin pointed out, I like to turn farms and forests into numbers. This is the first attempt to go at that. What I will do is sort of real estate in the next couple slides what exactly this means in terms of how do we try to calculate what these costs might look like. The first example comes out of the world resources Institute where we are looking at the net costs and benefits of doing some kind of cover cropping. You might think initially when you sort of think about implementing something you are going to look at the cost. How much, on a dollar per acre per year basis doesn't actually cost to just basically buy the seed and plant the cover crops? That might be on the lines of $44 per year. With that, we have a number of short-term benefits that are potentially gained which we can actually put a monetary value on. That's like reduced soil erosion, weed and pest control, reduced fertilizer use and increased yield. All those actually have value that basically come along with implementing that practice. Such that actually, if done correctly, you can almost have a net, basically a net cost of zero. Even though you're putting in $44 for the getting the cover crops basically on to your land, you might see the short-term benefits as a result. In addition, you can think of more longer-term benefits. Could be some yield resilience to drought and reduced fertilizer use that could lead to enhanced fertile bilberry as well. That leads to that project having a net benefit in this case such that you're going to get not just the basically some return on investment, but I know still fully almost a two to one return.

In addition, there might be circumstances where the cover cropping can lead to reduced soil compaction. You might be able to do forge sales from consuming some of the cover crops. That can increase your bottom line even more. That's kind of a way that we try to think about these different costs and how they might measure relative to benefits. In this study we are looking at measuring the benefits associated with the carbon sequestration that comes from giving a certain amount of practice. Recognizing that that's really a lower bound of the potential benefits that you can get from implementing these practices. In some ways we are also looking at changes in yield and a little bit about change in fertilizer use as well. All right? The key here is that these figures really show detailed costs, but they are not including the mitigation potential. We don't really know how much we are going to get in this case. We kind of know the financial bottom line but we don't know what the true efficiency is in terms of mitigating greenhouse gases. All right, so what I want to do is look at an example of how we basically calculated the benefit, or sort of cost-effectiveness of adding biochar amendments to Maine crops. The first thing we want to do is look at the technical or physical potential. The first question we have there, the first thing we want to look at a sort of what's the baseline? What are people doing in Maine right now question mark right now we are unaware that anyone is implementing biochar besides in a very, very small sort of garden scale or maybe a small level. Within the state, we've assessed that there's about 355,000 acres that has basically the fiscal potential and the sort of current agronomic system to allow us to implement and put biochar as an amendment into the soil. In addition, research indicates that for every sort of acre that you put biochar on, it yields about 1.6 metric tons of carbon dioxide equivalent in terms of additional soil carbon. Which adds can be assisted of negative greenhouse emissions. In total, you can get close to 568,000 tons of carbon dioxide per year. If you go back and recall that Maine's agricultural sexual emits about 400,000 tons of carbon dioxide equivalent per year, the potential if you can figure out how to scale up biochar across the state, it could potentially make the sector carbon neutral. Or, not zero. Actually net negative. None of this is costing about what the cost may be to actually implement this. The next thing you need to do is look at the economic costs. We know that there's 350,000 acres that we deem to be physical. We estimate that basically the process of adding this biochar amendment in terms of buying the basically getting the source of the product and then basically sort of amending it basically telling it into the landscape. Then, money is about $41 per year. We know from a previous calculation that you can get 568,000s tons of CO2 equivalent. That means that for basically every ton of CO2 mitigated, or the additional sequestration that you get, basically is $41 get you 1.6 tons per year. That means it's about $25 per ton of CO2 equivalent. The reason we measure things like this is the first of the general sort of way that greenhouse gas emissions are estimated. They are always in pretty much tons of carbon dioxide equivalent to some degree. This is when we talk about purchasing carbon offsets or allowances or what is the price of carbon. It is pretty much always measured in a ton of CO2 equivalent. That's why we kind of put it in that metric as a way of easily comparing can you invest in biochar amendment, or if you were to invest in converting to solar, or electric vehicles. They are all sort of measured in dollars per CO2 equivalent.

In addition I kind of gave the great technical potential. If we could get everyone sort of a long, across the landscape to implement this, that's what we would get. Is also other barriers to adoptions. This perceives risks about implementing this practice. Sonja is going to talk about that. It is also technical knowledge. Not everyone knows what biochar is or how to use it. Then, there's farm system compatibility. There are certain systems that it really does not make sense to use biochar or other practices that we want to talk about. That

can also constrain really where you go from what is the technical or physical potential, to where I would say it may be an economic or even an sort of a political or social potential as well.

The other thing that was sort of used that motivation as I indicated, there have been studies in that space that have been conducted across the U.S. One of them being led by the nature Conservancy back in 2018. What they did is they assessed what greenhouse gas mitigation potential was from a different ag and grassland natural climate solutions. They found that most of the potential can come from aborted grassland conversion, cover crops, but also biochar, as well as a number of sort of different practices as well. One thing that sticks out here is Maine does not have a lot of grassland to begin with. So, we are not really compatible to think about how many emissions we can avoid from aborted grassland conversion. There are some grasslands and croplands that are converted. Roughly along the lines of a few thousand acres per year. It's probably not large enough to really think about what the, saying that that's going to be directly in line with what we might find along the line of, across the U.S. That provided us motivation to say, we know that there is methods out there. We know that there have been some numbers put out but how does Maine lineup compared to the rest of the U.S. and the world?

So, I'm going to pass that back to Sonia. I kind of let it already in about what about Maine? Back to you.

Yes. So, what about Maine? To date, as most studies are global and national in scale. But, state-level estimates are important. They are relevant to our stakeholders in the state of Maine. They are relevant to really kind of get into the weeds about what makes sense on a finer scale. To date, the studies that have done state-level estimates often use assumptions that are more applicable elsewhere. So, in this study we really could had to take the approach of making assumptions that make sense for our people in Maine. Similarly, practices covered in larger studies are not necessarily applicable to our systems and are often applicable to more conventional agricultural systems or things that are dominant elsewhere. We don't grow a lot of corn in Maine. So, studies that focused on sort of corn/soy systems are useful. We would really like to be studying blueberries and potatoes, which I feel are crops more applicable to us. Then, certainly local knowledge about specific implementation barriers are important to understand. If we are trying to actually increase production of natural climate solutions. In the broad sense.

So, here are some agricultural natural climate solutions. We decided to consider that we thought were of relevance to Maine. Riparian buffers. Planting trees along waterways. Converting annual cropping systems to perennials. Incorporating biochar into a variety of systems. No till and reduced tillage. Daily manure management, and some others. These are a snapshot of several that we did decide to consider.

In this next little section of the talk, we're going to talk about the technical and economic potential of agricultural natural climate solutions in Maine. Starting off with getting a little bit more into the weeds on the method that we used in this study that we did. So, our approach was a financial and agronomic response analysis. We looked at major crop area and dairy farms across the state of Maine, which encompasses about 400,000 acres. We looked at a time span in the near future, or sort of recent past near future from 2017 to 2037. Established as sort of a baseline what are the current practices and emissions by crop based on USDA census data primarily. Then, we looked at opportunities to incorporate cover crops, reduced tale, no till, biochar, diversified rotations, manure management, and set-asides. Into our existing crops in the state of Maine. In terms of mitigation, we estimated the amount of mitigation that we could accomplish theoretically based on the literature. To the best of our ability drawn from studies that had some similarities to Maine or were based in data that we felt was as applicable to our system as we could get.

A little bit of a reminder, because I know so many of you are from outside my wonderful home state. Also, Adam's wonderful home state. Maine is mostly forest. I think I saw someone has asked a question about that. We may come back to it at the end. We are a very forested state, but agriculture is nonetheless very important to us as part of many people's way of life. We do grow a lot of potatoes. We have amazing low bush or wild blueberry fields. There is a dairy sector, so there is lot of hay and Haley's and grain and silage corn. That is part of that. We also grow other grains. We have apples and some other perennial crops and a good number of sort of other smaller niche crops including a thriving small-scale diversified vegetable farming scene. So, that's a little bit about what we grow in Maine. Our potatoes are mostly grown up in the northern part of the state. Blueberries are kind of grown down East. Some of the other crops are a little bit more central or widely distributed.

Passing this back to you, Adam.

All right. So, we kind of, Sonja did a nice job of sort of laying the groundwork. Literally. The next few slides are just saying well, what are the numbers that we came up with? Sort of before I dig into this too much, I do want to point out that we do have a very extensive report as well as a number of fact sheets that are available through some of the links, including the websites. I know people are already pointing out questions. I'm sure there's going to be a lot more questions that arise than what weaves covered specifically here in the webinar just in terms of times. If you go to basically our website, our report has a whole kind of

knowledge and information that really goes behind all these numbers that we are now going to present in the next couple of slides.

So, the first thing you kind of want to think about if this sort of practice efficiency or technical efficiency. If you implement some sort of practice on a given acre of land, all right, depending on what kind of crop it is, it gets some variation in terms of the mitigation potential. On average, we are sort of taken the average across our study and saying well, if you did a riparian buffer conversion of annual cropping to perennials or biochar, all those are expected to yield much more than a ton of carbon dioxide equivalent per acre per year. So, that indicates that at least on a servant of per acre basis that has quite a lot of potential. On the flipside, amending crops, crop land with newer planting cover crops, or doing reduced tillage, really is expected to have very minimal benefit in terms of actual just enhanced carbon sequestration or greenhouse gas mitigation. Switching to know till as opposed to reduced till is expected to have a little more, but sometimes not nearly as much as some might be based on the literature. The key here is this is just on a per acre basis. If you have a lot of acres that you could potentially implement this on, perhaps the numbers would look a little bit different. What we want to think about is economic efficiency. If we go and implement a process on a given acre, how much per acre, per year, is it going to cost? This comes back to the example on biochar that we estimated it is $41 per acre per year. In the previous slide I show that riparian buffers have a lot of mitigation potential, but we also found they are quite costly. Between the actual needing to pay for speed plus labor to plant and protect those seedlings as they mature. Coupled with the opportunity costs of taking some land out of production while you plant those riparian buffers, means they can be relatively expensive. On the same extent, the effective cover crops might have in terms of cost of implementation, particularly buying the seeds and stuff, specifically Maine system. We found that they were actually quite high too, which is just so much different than the example I showed from the WRI legume planting example. That might have been done on a more sort of conventional crop in the Midwest. What we find here in Maine is a cover crops are actually relatively expensive. Some of the reduced telling, relatively low in cost compared to some of the options. As we saw that the mitigation potential is not that high. When you take those two and put them together, you might see sort of a sort of slightly different picture. The sort of third access that you want to measure this on is where is the potential area that these practices can be implement it. Again, here we aggregated over all the crops that we think that it has the potential on. Based on largely based on the Maine land cover table and map that Sonja alluded to a couple of slides ago. From here, we found that basically there is a lot of potential in terms of converting lands with perennials. That is pretty much anything that is annual cropping system right now in Maine. Many of the annual cropping systems in Maine can also be implemented with biochar. As our cover chops can reduce tillage. The amount of practices that we can do no till from is significantly less. A lot of that has to do with some practices you can't really sort of switch to no deal. Blueberries not really a tillage practices. You can't really implement that. Forest already in that. The other big one is potatoes. Potatoes can really from our understanding talking with a number of farmers and extension agents is that really at best it's a reduced till type of system, however you can do cover cropping with potatoes. There are options or opportunities for all of Maine's major crops. If you take those three together, use the calculations that I showed on early examples, or biochar. You get this. This is basically the sort of, the key summary of our sort of numerical analysis is saying which practices basically producing the best bang for the buck in terms of producing the most mitigation potential. So, the further the basic, the bigger the bar, that means the more potential it has in terms of the mitigation reduction. Basically though, the more red the color that means the more cost there may be. What you want is bars to be sort of yellow or green. You want the bars to be large. We found there at least from a sort of cost perspective, really think that you might want to think about sort of first and foremost, if your goal is primarily to increase soil carbon or reduce greenhouse gas emissions from the ag sector in Maine is to focus on dairy manure management, conversion of some of that cropland to perennials. Or, taking some of that annual cropland and amending it with biochar. All right? In addition, we have to note that some of these practices can be done in tandem. You can't really convert to perennials and do biochar, but you could at the same time dairy cows are basically not competing with the same land that might be used for biochar. The ones that we put in red, are ones that could be basically simultaneously implemented across Maine's landscape. Collectively if you put that together, we found that collectively if you can reduce close to 800,000 metric tons of carbon dioxide per year from Maine's agricultural sector, at an average cost of about $34 per ton with CO2 equivalent. What that means is again if you go back to sort of the comparison of what sort of Maine's greenhouse gas emissions footprint looks like. Total missions in Maine are about 18 million tons of CO2 equivalent per year. Agriculture right now is about 0.4. That is that 2%. It looks like the mitigation potential that can maybe get up as much as 0.8 if everyone sort of implemented everything perfectly across the landscape is not going to necessarily help. It's going to help, but is not going to -- Is not going to slowly allow Maine to achieve its net zero target. But, the big thing here is it does allow, so there is a very strong potential technically for Maine agricultural sector

to be net zero. Or, even beyond that sing, which sort of would be a huge, huge accomplishment within the sector. That means that Maine's agricultural sector has the potential to do more than its fair share.

All right, so I'm going to pass that on. That's really kind of what we do in terms of economic and physical potential. Sonja is now going to introduce some barriers and opportunities to actually help us identify how close we can get to what those sort of final bars maybe.

Thanks so much, Adam. This is really also kind of a launching place into the next phase. As Adam mentioned, and I'll put another really subtle plug for it here. We do have an interim report and some fact sheets that are based on this initial round of modeling that you've just seen some data from. We are sort of revising this modeling approach. Based on feedback that we've gotten from experts and also from farmers who participated in case studies and other folks who weighed in and told us how we can improve our assumptions and really be hopefully better reflecting reality on the ground in Maine. So, I'm going to highlight some barriers and opportunities for implementing natural climate solutions that were discussed in a series of four focus groups we conducted with growers in Maine over the course of the last year.

These are kind of some take-home messages. So, our first focus group we conducted with potato growers up in Caribou, Maine, last January. We had 16 participants including a couple of organic farmers and several crop advisers. Some things that farmers shared in these focus groups that really seemed like news we could use was they were open to looking at longer rotations that include more perennials. But, there is an opportunity cost to that. Transitioning from -- To a longer potato rotation would have real soil health benefits and potential carbon benefits, but what growers said they would need is some payments to transition to a longer rotation. Because the cash crop in this system is really potatoes. That's where you make your money, and then in the year, or two years that you are growing a rotation crop like a small grain, that's a much less lucrative thing. So, if growers could be incentivized to adopt a longer rotation where maybe they are growing potatoes one year, and then rotation crops, including maybe a perennial crop for three years, and then back to potatoes. The farmers who were in our focus group said they -- They know farmers who have tried this, they have seen the soil health benefits and they would totally do it if they could afford to. But, the opportunity cost is a barrier. They also talked about some of the existing incentives for cover crops being a bit of a challenge in that they get paid if their cover crop actually comes up and you see green in the field. I think there are some advantages to that system, but a challenge is that some of these potato growers wanted to plant cover crops after they harvest potato in the fall. It's risky to plant the cover crop at that point because if you get an early winter essentially, you may not see green and you may not get paid for that cover crop. They also talked about, and this will I think be no surprise, less bulky paperwork for reimbursement programs. It mentioned they would be interested in nurse cropping. Interesting cost shares around that. There were some other strategies around tillage that were of interest and sort of crucially, most of the potato growers we talked to had never heard about biochar but they were interested in learning more about it. If the price point was comparable, they said they would think about it.

I have focused a lot of potatoes because that one is a really big opportunity I think in terms of the improving soil health and the strategies within the state of Maine. In order to stay on time I'm going to clip to the others a little quicker. We interviewed, or had five participants in our organic vegetable focus group back last February. Here, growers said they had a high willingness to prioritize soil health and felt like that should be incentivized. Cost of organic cover crop seed was a barrier for these organic growers. They were interested in strategies that were really able to be tailored to smaller scales. So, tailored solutions that are applicable to their growing system. In addition to agroforestry is mentioned as an additional NCS we could consider.

Talking to blueberry growers, just this January. Labor came out as a key constraint in every aspect of management, including NCS implementation. Here, really the natural climate solutions that were of interest to growers are potentially applicable were mulch, which is one that we hadn't included before but have decided to add to the next phase of modeling based on input. Here again, there was some interest in biochar, learning more about it. Some real questions about well, how would that work in our soils and what are the long-term implications? Really indicating a need for future research.

Finally, we conducted a focus group with dairy farmers. This had a great mix of organic and conventional participants. Here, economics was really a key consideration with some of the manure management practices, including methane digesters that we were talking about. These growers had interestingly really mixed views on biochar as a potential soil amendment practice. In part, because they have had major issues with PFAS chemicals in the past. This group of growers was I think suspicious of potential outside input where they were sure where that material was coming from. That's a real concern for the folks we talked to. Here again feed -- See price for cover crops was again crucial. There's a lot more I could say about these postal groups, because they're wonderful and rich conversations. We are going to be doing a more substantive, qualitative analysis of these data, and stay tuned if you want to learn more in the future. For

now, I'll pass it back over to Adam to wrap up. Great, thanks Sonia. In the end, that's basically the state of where we are at.

Four, the state of Maine in terms of the potential that agriculture can sort of implement and contribute, implement natural climate solutions and contribute to reducing the state's greenhouse gas emissions and helping reduce mitigation targets. Just to summarize really the top natural climate solutions that we found for Maine were a mix of biochar applications and amendments. Manure management, particularly with dairy herds, and the conversion of some of the marginal croplands to perennials.

Many of these solutions are limited by the area extent, or the low greenhouse gas benefits such as no till. That looks good and some other parts of the U.S., might not be the most cost-effective option to pursue here in Maine. I'm coming to the punch. You will have to come back tomorrow to really get what bullet three is. Generally we found that compared to forestry, a lot of the practices we talk about here are more expensive. A lot of the forestry options came in at under $20 per ton of carbon dioxide equivalent. The key thing here is that the ag sector can really play a part, if not sort of exceed its part in mitigating greenhouse gases within the state. Therefore, could be carbon neutral if enough farmers sort of have the right incentives to adopt these various solutions.

Finally, just to really summarize all the great knowledge that Sonja came up with, is really additional financial and technical assistance really could help to accelerate this in fermentation. Farmers really interested in learning more about these emerging options. They really needed to have more input from a variety of sort of practitioners before they sort of considered implementing on their farms.

So, with that, I just want to let you know if you want to know more about anything we talked about today, and more, that you should visit the Maine natural climate solutions initiative website of which again the link is included with this webinar. Finally, just want to thank all the collaborators, funders, and colleagues who have sort of made this great work possible. With that, I think that's it. Happy to take some questions and handed back to Erin to moderate the last 10 minutes of the webinar.

Thank you, Adam and Sonja. That was awesome. Fantastic presentation. So, now we are opening it up to Q&A. I have a few questions already in the chat box. I also wanted to say that several people are writing that it was a very useful and informative talk. So, thank you for that. We should have time for a few questions here. Going back to kind of the beginning of the presentation, how do you calculate the values used to measure costs and benefits for comparison purposes? Specifically are there critical assumptions that were part of those calculations?

I can take that initially and Sonja you can fill in because this was definitely not only was this presentation a tagteam event, but there was a number of us that work to try to get at it. We really tried to take this as semester as possible. Initially just picking was sort of USDA based numbers or Maine extension based numbers that were collected from the field on initially just the baselines. What the typical farmer is doing out there, how to construct financial budgets based on the typical amount of inputs that they put in. What's the cost of those inputs faced. What yields are they accruing. Then, we tried to do the same thing where we would implement a practice and therefore then maybe have to come in the course of having to implement no till, that might mean that there could be some cost savings from the amount of tractor hours that you have to run. At the same time they would maybe have to adjust the yields with could also have an effect. It's really kind of going detailed line by line and any sort of agronomic or financial budget that someone would have to implement on the farm, and going line by line and adjusting such that the system is still feasible, but is meeting sort of the needs of what the practice is expected to do. Again, trying to be as consistent as possible in the approach and where the data come from across both the number of different types of practices but also the different types of actual sort of crops that are grown across the Maine landscape. There's a lot more details in our actual report where you can sort of look at line by line how we calculated all of these. Hopefully this is at least help you in the right direction.

Adam, as a follow-up to that, there was a question about how soil compaction was valued in the cover crop example. What assumptions were used for that. The my grades. So, we didn't actually, we did not estimate that. That was an example we used from the world resources Institute just to illustrate the wide array of benefits if you have the knowledge and data to do that. That was not one of the benefits that we actually calculated within this sort of initial phase of our research. So, in the numbers I'm showing right now, that that was not included, there are sort of different ways that you can go about and do that, but sort of outside the scope of what we talked about here. I'll just leave it at that as opposed to giving you a detailed sort of discussion is how we can actually do it.

Okay. Great. If there is any resources that point to that, maybe it's something we could follow up with.

Yes, and I can point people to the source of that study that I used there. That might help.

Yes, that would be great. Okay, so there's a couple questions about biochar. One of them is about how you accounted for the net lifecycle of emissions of the application. So, you used that whole process in your

calculations. Which I see you answered. The other question is about how biochar can be created and kind of this relationship between forestry with different types of wood and repurposing as a soil amount.

I can talk about the first, and then Sonja you can chime in. The primary feedstock that we assumed in Maine, biochar to be made of wood be wood. Some of you might know that a recent announcement as recent as I think about two weeks ago, that the first biochar plant in Maine is going to be conducted. At least there is a feasibility from actual supply. It basically comes from basically taking wood residues and repurposing it. After processing at a very high heat through paralysis.

Part of that question too that I missed I'm sorry is if the net emissions actually includes the beneficial use of the heat process. The processed heat, sorry.

Yes. Yes, they do. We assumed how they would be made out of, basically it would be a byproduct of some other industrial process to make the biochar, which it would be sort of an integrated system. Yes. Great question.

Okay, I am getting several questions on manure management. Can you be more specific about what you mean by dairy manure management? Is it the setting, production, what stages are we discussing here? [Indiscernible - multiple speakers]

We glossed over this and no detail whatsoever. I don't blame people for having questions. Part of the reason we glossed over it is because we actually were set at a number of practices. Several kinds of methane digesters were considered as a way to reduce emissions from manure. We also looked at solid liquid separation as a practice that can be used, often in incorporation with a digester. We looked at manure amendments as a practice. As well.

The bulk of the sort of large emission productions, they are coming primarily through the use of some sort of anaerobic digester. Basically you can trap the -- You can basically put the manure in the digester, track the nothing, use the methane to either offset, basically to use as a substitute for natural gas. That's the sort of the way to make this more economical. As well as mitigate some of the omissions as well through basically a substitution of that.

There are so many great questions. I really appreciate this. I think we might be able to do -- I'm going to pick one more and then hopefully we'll be able to follow up with the rest of you. We will post the answers to the webinar archive. For the last question, this is a problem that we have a lot of times. Adam and I are all on other products thing about this in terms of adaptation. Elizabeth marsh asked would adaptation a factor for consideration in this project? She specifically Kinder points out this, the no-till ranking in your analysis.

Can you say that again, Erin?

How does adaptation, yes. Right. So, explicitly it's not accounted for again in this phase, right? Implicitly, the region that natural science are promoted is there's multiple benefits I can accrue. We are actually in sort of the next phase of this project we are looking at not just adaptation and resilience based things but Sonja mentioned soil health. I like to think of a lot of land-based practices looking at it from an ecosystem service protector. Looking at this from a much sort of wider lands in terms of what benefits can this provide to the farmer beyond just carbon mitigation and maybe some shifts and yields. There is some that you could quickly look at and say things like cover cropping is one that tends to be touted as a more, basically a way to improve -- Resilience. Some of the right carrion buffers. That has ways we can reduce runoff and other aspects of that. Deal with mitigating some potential sort of low land flooding issues. Other aspects of that. So, there are some things here where they are more directly adaptable if you think of an adaptation based process. Other ones maybe not so much.

Well, thank you. Thank you for that. That's it for timing for us. The presenters will try to follow up individual through the webinar portal archives. Back to you, Jen.

Thank you, Erin. On behalf of the USDA and the natural resources conservation service, I wanted to say thank you to Adam, Sonia, and Erin for providing an excellent presentation today about the benefits and costs of mains natural climate solutions about agriculture. Thank you again to everyone for attending today's webinar. Participants, don't forget to provide your feedback about the webinar and if you selected turn CEU's, please return to your open browser windows, and continue the process offered by step two, conservation webinar. This concludes our webinar presentation.

[Event concluded]