Good afternoon. Welcome to today's webinar. Helping cattle producers making more informed decisions about soil carbon and grazing. Am a natural resource specialist for the natural resources conservation services national technology support Center. I will be your host.

I would like to take a moment to remind them that this is for information purposes only. It does not constitute a guarantee of the product nor does it imply endorsement by the department or the natural resources conservation services over comparable products that are not named. With that, we will now begin. At this time I would like to welcome the moderator. A master of science degree from Oregon State University beginning his professional career as a research associate from Miles city Montana. He spent the rest of his 34 year career with the forest service as a conservationist in several Western states. After retiring he returned to the federal government and begin working with the NRCS a little over a year ago in this position one of those we are going to hear about today. Tom you may begin.

Okay. Thank you again. I really appreciate your efforts and scheduling with this webinar. I am the national grazing domain for the NRCS. One of my primary responsibilities is to oversee the applied CSU agreements that we have with the University. These agreements are part of the property study that is part of a natural consortium of academic agencies working together to support informed resource stewardship. The agreements been together resource managers students and other conservation professionals for collaborative products and issues. As they've said, we are going to hear today from the results of one of our recently completed CAC a you projects that address soil health and grazing trends within Wyoming by Doctor are Tim or Gini. He grew up in Brian Texas and received his bachelors degree from Texas A&M University. And agricultural development. He then received his MS degree in agronomy from the University of Wyoming in 2015 and a PhD from the University of Wyoming in the spring of 2021. The team is currently a research associate looking at the economics of suppression. In addition to sustaining the management assessment tool with range thing cattle producers. Ultimately the goal is to be a grazing and so will racers contact through one-on-one conversations with Western rangeland producers for information and advice that can become conflicting, complex or just plain confusing. We can all use help in that arena, for sure. So, before I turn this over I would just like to remind folks that there will be time for questions. Please enter them into the chat. At this time I will turn it over to Kim.
Thank you. So can you hear me?
Yes.
Perfect. As Tom said my name is Tim Burgundy and I am from the University of Wyoming. Thank you to the NRCS sustainable table researching the practical aspects from the graduate work. I will talk a bit about that work now. It seems to be complex and confusing. I just wanted to talk about it in a way that makes sense to me by providing some background information with the global literature review and skill studies that would need to be performed. But first I must mention that my goal today is purely informational. I'm not giving a recommendation beyond that management. However my intention is to use this information that is being represented to make your own decisions. I also want to mention that the information in this presentation and any supplemental information therein is currently under peer review for potential replication. This may be the most important our original research tasks was to simply explore the practical aspects of soil health for ranchers. Not for rangeland or soil sciences. It means to simply be able to monitor their management over time for profitable sustainable cattle production. Not for sequestration or storage. Frequently get questions from producers which are basically what and how should we be monitoring and why? And the data driven research and review to provide credible information and advice to regional producers when they are seeking input. So, what do we know or not know about soil health based on these published studies it appears the research outcomes of these effects on soil is very complicated to say the least. What we do know is that soil organic matter is heavily influenced by the environment as illustrated by these graphs. Making recommendations site Pacific. But there may be others with soil carbon responses that could increase scientific, social and interpretive factors. It identifies both traditional and contemporary factors that can be influencing different outcomes with grazing and soil research. Before I get started I would like to read these points. There are important statements about soil organic matter and carbon. The hub of the terrestrial part of the organic matter contains roughly 50 to 58% of carbon. Due to their strong interrelationship it is a practical management indicator as long as it sticks with just one. The fuzziness of the matter with carbon, grazing and reporting technology increases the uncertainty about the cost of the changes of soil carbon and reduces will comprehension. Some research has leaned toward comparing two areas of

different management history rather than monitoring one place over time. And this is highly troubling. Soil carbon can be divided into two different categories. And they are commonly measured attributes with the percentage of change or tons of carbon per acre. It requires measurement of only one parameter and that is the carbon percentage within the soil. So for the purposes of feedback to management or establishing that management is affecting soil health the percentage may be all a producer or rancher may need to monitor. In short, this reviewer highlights the wide array of resource techniques and responsible characteristics that have likely attributed to a variety of grazing research outcomes. The scope is based on the statement of global rangeland primarily for stock and inherent properties and limitations other instances of agriculture. Soil health has become a point of interest with persistent questions from producers. Producers frequently question what soil parameters they should be monitoring if any at all and what exactly they are supposed to do with those lab results. The complexity and confusion surrounding the soil health may in part be functional of the dynamic array of lab analysis, affordability and reporting terminology discrepancies resulting in a lack of comprehension and applicability. What is soil health? And how can we monitor it. There is continued capacity of solar function providing sustainable plants animals and measured by many properties. With it array of field and lab measurements for this analysis. Ultimately affordability of the analysis and contribution to each of the physical chemical and biological soil properties it could be argued that this is the most practical indicator for ranchers. We believe that our field study does identify this. In addition, we believe that soil organic matter is best based on cost, stability, comprehension and contributions. So, lab analysis on organic matter is roughly around five dollars versus $80 for the biological community, $50 for some soil health tests, 19 for soil chemical analysis, basically any amount for physical testing within the field so that is five dollars versus roughly what could be $150 per sample. It is stable which means that this physical state is not fluctuating within the short term relative to current environmental conditions as many of the chemical and biological responses may therefore it makes it a very suitable baseline as organic matter positively influences physical, chemical and biological. So why would they measure this if they were trying to be practical? As far as comprehension, if you don't have organic matter you simply do not have soil health. I also like to call it an affluent indicator with mismanagement especially in our part of the world. Sorry for my redundancy. But the intention of the review is to understand the available research for semi organic carbon I systematically reviewing the global scientific literature. To utilize that information in the outcomes of this review is a tool to provide a regional producers with a potential explanation and information about grazing and soil dispelling any misinformation and ultimately create a unique dialogue that's been missing for future discussions with rangeland livestock producers about the practicality of swell health and monitoring to inform the grazing management decisions. So, we used two online databases for review and simply matched each term with each soil health term. The search terms were grazing rotational grazing, grazing management by soil organic matter and oral Berg organic carbon. So this may not be true for some audience today. The operations here but our search criteria and field site to the best of our knowledge were undisturbed native range land. We reviewed studies explicitly exploring the effects of cattle, sheep, horses or livestock on soil organic matter or carbon on native range land. It was not considering any species other than the previously identified being included. For example the wildlife. The exclusion also incurred in studies that were conducted on irrigated fertilize plow intentionally burned, herbicide it, based on models or any other site deemed unnatural or highly unique and there must have been a reference within the study to be included. The information that we extracted was near the response versus the ungreased control and the treatment age. If there was an actual year one baseline sample of reference, when the study originally started the annual precipitation temperature, soil type, sampling depth, and if there was a stock density or reference or was or was not an annual forge production reference than we wanted to know the study on a working ranch and experiment station or potentially where there was communal grazing occurring. We ultimately reviewed about 1000 studies. 2010 was the average publication of the field study the studies range from 1977 to 2021. There were 42 different field studies that were identified across 60 different sites with 107 total raised in ungreased comparisons on four continents in nine countries. Of the 42 studies, 20 studies were in Asia were sheep were the main grazing. Were 90% of the land is degraded and these were more restorative studies. They were identified within Africa and there were similar to the Asian studies. 17 were identified in North America were cattle was the main grazing species. And this was more of an exploratory enhancement study were one study in Australia which is similar to North American study or research objectives. This is a map of your search results. Average annual precipitation by sight was roughly 15 inches ranging from 4 to 36 inches. Average temperature was 45 degrees and range was little less than freezing to around 70 degrees. The majority of the studies occurred at less than 15 inches of precipitation total felt will only five were greater than 24 inches of precipitation. Interestingly enough no sites utilize horses with all of the interest now around wild horses. 19 site were here and 44 sites for research facilities and seven sites practice communal grazing. This slide may be the most important in identifying the wide array of responses

to grazing not to mention diminishing chances of research replicability with 20 sites not indicating spot density. 38 excluding annual forge production and 14 sites failed to report quantitative stocking rate data. Only 17 sites practice continuous year-round grazing. Five months was the mean of the average grazing season and four sites implicated winter grazing. Relative to sampling and reporting, the average of three soil depths were sampled ranging from 1 to 9 per study. 11 centimeters was the average of the first steps. So roughly let's say four inches or 39 centimeters was the average of the last depth. Five 200 20 centimeters was the total range of depth. So about four feet. All soil types were reported. There was the soil organic carbon percent 12 had concentration 16 reported a both and only two of the studies indicated that there was a year one baseline organic matter organic carbon sample in existence. Among the 60 sites that were identified there were 12 positive responses for the soil organic matter grazing. 33 negative responses and 56 times there was no response to grazing detected. Within the literature and correspondence there's frequent terminology such as intensity with stock rate versus density. Control is also called within the exposure and continuous if it's not 12 months is it really continuous? Rotational? How many move and for how long qualifies as rotational grazing. Anecdotal versus quantitative stocking rate descriptions. And once again just understanding organic matter versus organic carbon. The units can get quite confusing. Warmer talking about content and concentration and then it needs to be understood. To that point, understanding the difference between carbon and different carbon pools and the responses to grazing is imperative. For example on properly managed rangeland, about 90% of soil carbon is stable. It is organic and it reflects the regional climate plant and soil interactions. It is resistant to minor disturbances and a better long-term indicator of management. However the other 10% is largely dependent upon moisture. It's inorganic it's mobile and it fluctuates into annually based on moisture with the less accurate management indicator as it is heavily influenced by environment. Some contributing factors or reasons for various responses with the soil organic matter are positive responses to what could be indicative of the transition from the cool season mixed graph to warm season short grasp that contains a shallow dense carbon rich system but may not actually be a positive outcome. A neutral response may indicate sustainable management and a negative response is usually the product of a legacy effect or overgrazing or overstocking. All organic matter are subject to some degree of author interpretation. Therefore some conclusions that may be drawn from previous research are that there is a large variation in research techniques, sampling procedures, technology and site characteristics. It appears to be flexible in semi grays land with historically practiced or adaptive stocking rates. Regional knowledge must be obtained before grazing recommendations are given. And this next statement I was in another chapter but organic matter inorganic carbon may not be the product of grazing management rather inform stocking mates may be the product. Neutral responses could indicate sustainability based on using the soil and forge resource of for livestock production and livelihood without resource-based depletion. Based on the 2010 average publication date, semi arid rangeland research could be considered in its infancy. Also, there is a large opportunity for more soil health research at the ranch scale. This is due to the small amount of studies that are done on working ranches. Enough talking about this other research. Let's talk about the research that we have done on the ground. The first project I'm going to talk about is the bottom ranch scale of valuation between soil health, and grazing capacity in high elevation range lands located at Sims ranch in McFadden, Wyoming. What we know from other published research other than it occurs infrequently is the outcome varies as well. Most likely due to geographical location and local climate. So we perform her own ranch scale study. And here is the regional map showing the location of Sims ranch in McFadden, with Wyoming where we conducted our own research. Sims ranch is located at 30 4A where they receive about four inches of precipitation annually an annual temperature of 40 degrees with about 90 frost free days or less. There located on a cold arid step at about 3300 feet in the northern mixed grass with shallow soil. Western wheatgrass is what they consider to be their main forged species. And the average annual production is about 900 pounds per year. Ultimately we sought to answer the following questions what is the relationship between soil and response variables and animal-based time in pasture? More specifically juice will response variables such as soil organic matter or organic carbon predict animal-based per acre or do the variables such as crude protein predict this approach based on lack of previously established baselines?'s however these measurements of established baselines are here for future research. So, what exactly is Annable Prager? This basically means the relationship between the forged research within a pasture and the ability to support the animals within that pasture for an amount of time. For example it equals 26 pounds per day for 9000 1000 so they require about 30 pounds per day. Therefore if they have 150 pounds available for grazing it would equate to roughly 5 per acre. Most producers want to know what is or is not working for other producers. So in order to draw even the slightest conclusions we must have long-term data collection. We have been able to do this at Sims ranch as they've been recording the duration in the pasture since 1989. Or animal days per acre for each pasture. They have over 140 pastures from greater than 1200 acres to less than 10 acres. We studied 11 native undisturbed pastors in three permanent closures. They

had 4 to 5 animal-based per acre. In order to conduct this research, we had to put the pasture into animal categories as follows. Low, medium, high and none based upon their respective animal base. We also had to consider that due to the size and topography that there would be multiple soil series all containing different degrees of inherent properties. Therefore, we sampled the three largest soil series within each pasture, inside the soil series boundaries while considering aspects. Samples were then pooled and wait bite-size contribution. Western wheatgrass was also at each sampling site. This is within 140 pastors. What I assume to be on the right side of your screen with red pastures and that's what we stuck to with our analysis as they fell into the native rangeland criteria. This is a closer look at the pastures which each sampling site indicated within the black and white circle. That is exactly where we took all of her soil samples. We use the analysis and programs within the data when we look at these four graphs to see what's will variables might be here per acre we find that soil organic matter and carbon may predict the animal-based per acre. These are the red and blue bar graphs on the top of the screen. The one on the left is the organic matter and the one on the right is organic carbon. However, water-soluble organic carbon and microbial restoration do not these are the two that are on the bottom. 21 others will response variables that were analyzed are included within this table. Only seven additional variables will found to influence animal base. Seven did not. Influencing variables were deemed irrelevant to the organic matter or biologically unimportant. No soil microbiology variable influence the animal base. These two graphs and one table show that only one out of 11 response variables may predict this is most likely explained within the higher pastors as well as within the exposures. So, why is organic matter useful to practical ranchers? Because it is the foundation for nutrient supports with rangeland plants and animals and is a potential indicator of carrying capacity with an inexpensive analysis that is stable and positively influences all properties us will health making it comprehensive and practical. In conclusion, certain soil health metrics may be useful indicators of greater or lesser animal base breakers such as organic matter, organic carbon however, organic matter inorganic carbon may not be the product of grazing management. Rather inform stocking mates may be the product of organic matter or organic carbon. But to find that out, ultimately baseline soil analysis must be catalogued for the most accurate chemical assessment of grazing effect which we now have for Sims ranch. Producers need data to draw those conclusions and not anecdotal information. The future sampling may detect the grazing influence per acre or if animal base per acre is just a reflection of what is needed within the environment. We can now accomplish this and then can we give heard recommendations. I do not put this in here, but, I think that the soil sampling at Sims was probably five to $7000 and once again that covers so many soil and four variables. But asking your producer to spend five to $7000 is a steep sell. And they don't know if what they would do with all of that. That is why we say that organic matter based on that cost and comprehension would be something that could easily be monitored for themselves. The second study that I will talk about is the four-year density study used to explore the effects on soil health and located within the Saric research center in Rhaegal Wyoming. But first, what we know about these multi-phallic systems? We know that there are many outcomes and implied impacts when using these systems based upon the studies. So we chose to explore the effect of grazing density on soil with our own multi-phallic system. Here is a regional map showing the study location at Saric near Rhaegal Wyoming. This location is at him LR a 67 a which averages an annual temperature of about 50 degrees. Grazing site elevation is roughly 4400 feet and is a northern mixed grass prairie on deep well-drained soils. The main species includes Western wheatgrass, needle and thread, and the annual forge production is about 1500 pounds per year. The distance between Sims ranch for reference and this site, I would say is a little less than 200 miles. And you probably have noticed about 4 more inches of precipitation and an average temperature of about 10 degrees warmer and for Wyoming that is substantial. And the forge production is substantially more in both areas where you can have a profitable cattle operation. But in that relatively short distance, you can see a variety of influences that producers have to deal with. This is a Google Earth view of the study area on a native grassland. The square is about a quarter section down at the bottom where you can see the 12 one acre pad. They are on what we can best determine is an undisturbed native rangeland. Outside of that it was planted in crested. We have no crested there. It is surrounded by pretty drastic draw so that basically kept it from ever having any kind of cultivation as far as we could tell. But that is why we chose this area. This and density study was replicated four times with 12 one acre paddocks. Determining the effective heard density at three distinct sampling times which were June 2017 pre-grazing, July 2019 and August 2019. Post grazing. The three densities were not grazed, or no cows at zero pounds per acre a moderate density heard of four 1200 pound acres at 4800 pounds per acre in ultra high density of 33 Cal KAPP fair at 60,500 pounds per acre. For reference, this is looking down the lane with the you HD heard in the block for Paddack on the left and the moderate size heard within the block one Paddack on the right. It is worth mentioning that the study is currently ongoing. We have run out of money but we are scrapping to find some elsewhere to keep it going. We've invested a lot of time and money into it so we are going to keep this one going as long as possible. So there has been five years but for the context of

today's discussion we are talking about 3 to 4 years. Are research questions were first the grazing density is applied to ultrahigh density rotational grazing monitor the zero rotational grazing or grazing and exclusion altering the soil health properties within a three-year time frame. Second is the swill health properties that will be altered within the direction negative or positive of the magnitude of these changes relative to the pre-grazing management strategy and third the grazing inducing soil health alterations being expressed by functional groups and ground coverage feedback. They collect the data including soil vegetation height and surface temperature as well as coordinates. Soil samples were taken to the depths of 10 centimeters at 60 foot increments and pooled by Paddack. Soil nutrient and biological analysis occurred in Carty, Nebraska. It is worth mentioning anytime we took soil samples, they were dropped off in Nebraska which is about 250 miles from the site within 24 hours. And then most cases less than 24 hours had gone by before they actually did their analysis. So we have that very distinct point in time for this data. Vegetation measurements included visual up structure reading functional group and groundcover estimates all at 30 foot increments. And biomass clippings and 90 foot increments that were dry at 60 four 48 hours. There was the height estimate at 20 by 50 Sumner quadratic with plant functional group estimates we determined that the time by pairing height measurement to predict the biomass within each Paddack when cattle remove 50% of the biomass the herd was moved to the next Paddack. Here are some of those results. With the four brass represented here which are soil organic matter total nitrogen, soil pH and percent of soil organic carbon we found no difference between grazing densities and swill nutrient response variables at any sampling time. In fact, when we look at all 15 swill nutrient response variables, we find no effective grazing density on the response variables after grazing has occurred. What this table is, the first columns are 2017 pre-grazing. So no grazing has occurred. The next two are 2019 one week post grazing in 2019 six-week post grazing. I don't know if you can see that, but there is a list of boxes here that circle I would say in red if there was a grazing affect by treatment. You would see a gray box in there but there was not at any sampling time after the post grazing. For the four brass represented here there is your total biomass with soil respiration and organic carbon and nitrogen ratios. We found no difference between the soil biological response variable at any sampling time. After the grazing had occurred. For the four soil or ideological graphs which are shown here there was a change in the soil surface temperature of percent of perennial native and percent annual exotics. There were 2018 post race soil temperatures and 2018 perennial native an annual exotic cover classes may have responded to grazing densities. Look at the data of the table. Relative surface temperatures could be attributed to uncooperative cloud cover at the sampling time and perennial native an annual exotic a cover classes that showed no response to grazing density as the following year in 2019. Litter and fairground did not respond to grazing density during our research. So if you look over here, you can even see the change in temperature regardless of the uncooperative cloud cover when you go to 2019, there is nothing showing a response. So, it is worth keeping the studies going to see the changes over time over the long-term. Just for our own due diligence, the graphs confirm that we have achieved our planned 50% forge allocation levels per grazing density treatments. And that each density treatment had similar stocking rates annually and cumulatively. Furthermore, graphing the average level indicates drought and how we adaptively manage for that drought by adjusting our stocking rates. Also, do not be confused by the high stocking rates on the right graph. They are reported within so if you wanted it for acres you would divide by 2.5. When I mention the stability of soil organic matter this is what I'm getting at. There's little to no treatment effect on soil or forge properties compared to the same sampling times and environmental conditions. Particularly over the three years. But with the slide represents is the environmental effect or variable of environmental conditions at each of the three sampling times within the same treatment or animal density within 2017 and 2019. Why this is important is that there are many response variables sensitive to the environmental conditions and time of sampling. So the producer or researcher is not aware of which variables are environmentally sensitive and may draw false conclusions of the treatment effect. My point is that soil organic matter and swill organic carbon are not sensitive to environmental effects within the short-term as illustrated within this table. Making them a reliable baseline and practical effect for management over time. So once again, all of the great within the charts could point toward that environmental effect. When you look at what is circled or squared within red, on that first table the organic matter and organic carbon state is consistent which is showing a good indicator over time that it does not fluctuate based upon temperature or soil moisture from time to time. In conclusion, it appears that from 2017 to 2019, heard density had little effect on soil or forge variables at similar utilization and stocking rates. However, a neutral response may be indicative of sustainability based upon using the forge resources for livestock production and livelihood without resource-based depletion which to me sounds like a positive attribute. And because will property evolve slowly especially in steps within these levels must be continued across geographic regions to catalog useful information for regional producers. Enrage land sampling protocols must be established and understood before accurate assumptions can be determined. Once again, I want to thank NRCS for giving me the opportunity to do this research. As

well as the roundtable which I appreciate very much as well. The University of Wyoming also very appreciative to them as well as Sims cattle company and this was my committee. Something that you may recognize with these names. If there are any questions, I have a few minutes to try to sort that out. So thank you very much.

Thank you Tim. That was very informative. We do have some questions coming in. The first question is are there any thoughts on the relationships of this effort with the work of Gabe Brown in North Dakota with grazing, carbon nutrients and soil health? You're probably familiar with a Brown's work in North Dakota. He has a few YouTube videos out right now. I don't know if he has written anything or not but he does have some anecdotal information out. I was wondering what your thoughts were on that?

Absolutely. I've heard of Gabe Brown. And I think one of the main things that excluded us from running across this level I'm sure it's been published but with our search criteria being here Wyoming and many places which are basically on the cusp of being a desert, the applicability of putting cover props or what Gabe does up there is not something that is practical or applicable to where we are in Wyoming. So that is the short answer. We really haven't because we couldn't talk to producers into doing that. I think they may have been pretty upset with us if they try cover props especially 7300 feet. With the average temperature at 40 degrees. So that is the reason why we have not pursue that avenue.

Okay. Thank you. So I have a question for you, both of these study areas were within this range would you expect a similar result like on crested wheatgrass or wild rye? Or some other non-native agronomic species on a disturbed site? Or would you expect something different or similar? Can you speculate on that?

I can speculate on that. We can call it that. My intuition on that level is the more inputs, the more grass you can grow you probably will see some gains. Because that's what they would be doing. When you plant something in and are adding that inputs, I do feel like most likely you are going to see some gains. But that is what makes it interesting. In this part of the world relative to something that geographically isn't that far away East to West. I bet where we are in Wyoming, and where Gabe Brown is in North Dakota it's probably not more than 2 to 300 miles East to West. It is just not applicable for here. I think you could expect to see something quicker.

Thank you. I have another question about the soil carbon and organic metrics. You didn't see any change in the term of your study. But you are thinking that over the long-term, five to 15 years out you may see something. So I'm wondering when you did your literature review was there some indication of a time period where if you're going to see change when that change would occur? Can you speculate on that? Was there any number or timeframe that you came across when you're doing your literature review on that topic?

No. In all honesty there is speculation that is all relative to local and regional environmental climate and factors that is the big question. If you're monitoring something I'm pretty sure there was a study out of Canada that after 50 years there wasn't a lot of gain. And that is why I make the comments that if there isn't a loss you've stayed profitable and used that for your own livelihood. You haven't lost anything. Would not potentially be considered a gain? That sustainability?

Okay. Are there any other questions? Okay. I would like to think you and one again once again for coordinating this throughout the webinar. Thank you for providing us a wonderful presentation we are pleased that you brought the study to fruition. We would like to congratulate you on the completion of your dissertation and wish you well in your future endeavors.

Thank you all very much.

I would also like to thank the audience for the participation within this topic. Have a great rest of your day.

On behalf of the USDA and the conservation service I would like to say thank you to Jim Tom for providing an excellent presentation today on usable science for producers. Helping cattle producers make more informed decisions about soil carbon and grazing. Thank you again to everyone for attending the webinar. Participants, do not forget to provide feedback about the webinar and if you've selected to earn CEU, his return to open browser window to continue the process offered by step two and conservation webinars.net. This concludes the webinar presentation.

[Event Concluded]