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The Role of Climate Research in Supporting Agricultural Resiliency

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Chairman Scott, Ranking Member Thompson, and distinguished members of the Committee, thank you for this opportunity to join you and offer testimony, in collaboration with Noble Research Institute, LLC, regarding the role of research in supporting agricultural resiliency.

I am a rancher from North Central Texas. I have been in the livestock business for all my of professional life. To provide context, after graduate school, I began to build my own cattle operation while also managing land holdings for others. In this capacity, I have managed up to 70,000 acres across 5 states. Without inheriting any land or ranching assets, I found it critically important to grow my own operations through strategic partnerships with others who valued the land and its health in equal measures to the profitability of the operation.

Today, I am the managing partner of Southern Reds, LLC, a 1,200 head seedstock operation. With the help of my wife and three young sons, we manage these livestock assets across 8,000 acres. We focus on raising climate-friendly cattle genetics that produce beef by recycling forage—grazable plant material—and water, without the need for added outside inputs that negatively impact the environment and our financial efficiency.

We seek landowner partners that understand the positive influence that livestock can have on the land. We see an increasing demand from those who desire to see their own land investments improved through true ecosystem management and regenerative grazing principles.

My experiences, these partnerships and my operations provide the background for what I will speak about today.

Before I address research to support agricultural resiliency in grazing lands, I want to provide context for its need and the environment in which I work—the nation's grazing lands.

Grazing lands are one of America's greatest natural resources. They represent the single greatest land use of this nation—found in all 50 states, grazing lands account for more than 650 million acres and represent about 41% of all U.S. lands in the lower 48 states.

Whether due to quality or ruggedness, less than 15% of these acres could support the production of human food crops or commodity crops, such as corn, which is often associated with agriculture. Nevertheless, the have a tremendous impact on human life.

Our grazing lands support those animals that deliver our nation and the world a high-quality protein source for human consumption, serve as a filtration system for our fresh water, deliver productive plants that nourish grazing animals and work to sequester carbon in our soils, and offer a robust wildlife habitat. The soils of these grazing lands serve as the foundation for our country's farming and ranching families. As of 2021, grazing lands contribute more than $70 billion annually to the U.S. economy by supporting more than 60 million cattle and almost 10 million sheep. To sustain

agricultural production, grazing lands must be conserved and properly managed to produce robust, resilient stands of grasses and forage. All of this starts below our feet with "soil health," the foundation of our operations.

Grazing lands are those lands not cultivated by man. As America developed westward in the 19th century, farmers began to cultivate soils by clearing timber and destroying many of the natural prairies that existed. This was to grow what are now known as "commodity crops." The fertile, productive prairies of the Great Plains that once teamed with diverse grasses, forages and large herds of bison were tilled and farmed. These practices depleted the soils of nutrients, organic matter, and biological life. The natural biological processes of grazing by roaming herds and periodic fire that created the natural grazing lands, were no longer at work.

Soil carbon is the center of overall ecological function in natural systems. Soil organic carbon directly contributes to decreased erosion, improved drought tolerance, plant root growth and production, the decreased need for synthetic fertilizers, and improved water quality.

Poor management practices combined with a decade-long drought contributed to the great Dust Bowl of the 1930s. This disaster brought about the birth of land conservation and the Conservation Act of 1935, which created the Soil Conservation Service, now the Natural Resource Conservation Service. Despite these efforts, in the 1950s the Green Revolution took hold, and advancements were made in agricultural technology, including the development of commodity and forage crops that responded well to fertilizer, advanced farm machinery, and other technological advancements that expedited crop production with less need for labor.

The nation demanded a cheap and efficient food supply system, and that is what we delivered.

The Green Revolution became more than an event; it became an agricultural philosophy. The United States built an agricultural sector based on four tenets that we now know are not true:

- Farmers and ranchers will have unlimited energy and cheap inputs.
- We will continue to enjoy stable climates and abundant water.
- Nature can be controlled by technology.
- Hunger will be solved by increasing production.

Premised on an oversimplification of a complex natural, biological system and our desire for a one-size-fits-all approach, our industry and our research during that time focused on the chemical and physical characteristics of soils with little to no consideration of biological interactions within the soil.

The consequence is an ongoing degradation of our soils. It is estimated that over the last 60 years, our approach to agriculture has resulted in the loss of more than 50% of our nation's soil carbon. The overall loss of soil carbon has a compounding effect—diminishing water holding capacity of the land and rendering the land more and more susceptible to erosion. Our reaction has not been to reduce our overall use of inputs that impact our soils. Instead, our blind reliance on technology and inputs has resulted in the increased use of inputs, such as fertilizer, to compensate for diminished land performance and resulting crop productivity.

With predictions for greater and more extreme weather events, landscapes that are low in organic matter naturally will not be able to cope with rain events and will soon become considerably more arid. These broken water cycles in crop and grazing lands will lead to desertification as well as continued depletion of important aquifers that maintain water cycles through the Great Plains.

We know an alternative exists.

Some producers have abandoned this production approach out of principal—knowing that is was

ecologically unsustainable and/or because they sought a food system not reliant on these chemical inputs. For a growing number of producers, however, drought conditions (for example, as occurring in our Western states) and/or prices for feed, fuel, fertilizer and other inputs have increased to a point that has become economically unsustainable for their operations. For these producers, a choice was necessary: continue doing what they have always done or work *with nature* to find a new way to farm and ranch. Born out of equal parts necessity and frustration, producers began to experiment with farming and ranching techniques that limited the use of feed, fuel, and inorganic fertilizers and other inputs.

They began to see that (i) limiting or eliminating tillage reduced their fuel bill, (ii) using the ageless practice of "cover crops" to keep their fields covered provided numerous benefits to the soil (e.g., preventing erosion, increasing water holding capacity and increasing biodiversity), (iii) converting marginal soils to perennial pasture land to eliminated tillage and minimized erosion, and (iv) through managed rotational grazing, the pastoral lands improved in composition and production due to the recovery allowed between grazing events.

In essence, they built a foundation of principles that many producers follow today to manage healthy soils and restore deteriorated soils. These soil health management principles were set forth to achieve specific goals that are inherent to all soils. They are based on mimicking highly diverse, heterogeneous, native grazing land plant communities by harnessing the power of biologic interactions among plants, soil microbes, fungi, and other forms of life in our soils, water, and animals. These principles build soil aggregation, which further builds soil structure. This soil structure enables the better utilization of any received moisture, whether through rain or applied irrigation.

These principles have proven the path forward for many innovative producers and substantiated that the conventional farming and ranching practices of the last six decades are not the only way.

The following six soil health management principles were developed by producers for producers, and these apply to both croplands and grazing lands:

1) **Understand your context:** Develop an on-going relationship with the environmental, economic, and social context of the land to identify which applications produce the most total value relative to their full range of costs. Context is a state of constant change and can vary significantly across time and space. There is no one-size-fits-all approach.

2) **Armor the soil:** Keep soil covered with growing plants, ungrazed trampled litter, or supplemental covers like hay or mulch. Uncovered, or bare, soil is more susceptible to wind and water erosion and less able to absorb and retain water. Uncovered soil is also exposed to the sun, which can raise its temperature, killing beneficial microbes and evaporating soil moisture.

3) **Minimize soil disturbance:** Physical soil disturbance, such as tillage, alters the structure of the soil and limits biological activity. Preserve the integrity and structure of soil and limit the amount of disturbance that can damage plant roots, harm the health and diversity of microbiological communities, and create soil compaction.

4) **Increase diversity:** Support biodiversity above and below ground and limit the use of practices or chemical inputs that can damage it. Biodiversity in rangelands is critical to their productivity and resilience; specific soil microbes require specific plant types. Encouraging a variety of plant species and supporting macro- and micro-biological diversity can extend growing seasons, increase resilience to extreme weather, reduce livestock predation and livestock concerns, support wildlife habitats, and enhance ecosystem function.

5) **Keep living roots in the ground all year:** Soil microbes feed on the carbon produced from

living plant roots. Therefore, a living root in the ground is ideal for active soil health. Living plant roots contribute to soil structure, increase water infiltration, support plant regrowth, and increase soil organic matter by exuding photosynthesized carbon into the soil. Increasing the diversity of plants, better enables a mix of species that contributes to year-long soil activity.

6) **Properly integrate livestock:** Use livestock to gaze and prune plants to promote plant growth, and then use the animals to provide beneficial nutrients back to the land. Thoughtfully managed livestock can both support and improve ecosystem function.

   The byproduct from the integration of livestock from U.S. ranching operations is the production of red meat for human consumption. Red meat has been an important part of the human diet throughout human evolution. When included as part of a healthy, varied diet, red meat provides a rich source of high biological value protein and essential nutrients, some of which are more bioavailable than in alternative, plant-based food sources. Unprocessed, red meat provides a nutrient dense food that offer more protein, per calorie, than nuts, fruits, or vegetables.

   It is recognized that an epic debate rages with respect to the impacts of beef cattle on the environment. This debate is fueled in two different directions: the first is meat versus nonmeat/reduced meat academics, and the second centers on a disagreement among animal, forage, range, and other ecological scientists with respect to best management practices of beef cattle production.

   A quick search of the literature will reveal a competing division of academic studies slighting the role of livestock in the environment and others that recognize the importance of livestock in the environment. The conundrum is all supported by the science. Good and talented academics are researching these areas and presenting outcomes that pass peer review and publish in quality journals. Yet, a divide exists. Why?

   Our grazing land environments are complex, and they are often ill-suited to be replicated for the purposes of short term or reductionary studies that attempt to isolate and look at one issue within a system. Reductionary research (i.e., attempting to simplify a complex system) cannot account for everchanging environment facing our farmers and ranchers. Scientists, in general, attempt to "control" an uncontrollable system in small, replicated areas and often the results cannot translate to a broader landscape

   Stepping outside academic studies, our world's grazing lands co-evolved with grazing animals in populations equal to or exceeding modern livestock populations. These grazing lands benefited from the impact of livestock browsing, grazing, trampling, and recycling nutrients through saliva, urine and manure. The fertile grasslands and rich soils of the Great Plains (and other regions of the U.S.) emerged, in part, due to the seasonal migrations of antelope, elk, and bison. During their migrations, these herd animals moved frequently for both fresh forage and to stay in advance of predators. **Their grazing and movement created a beneficial disturbance benefiting the soil, plants and ecological processes**.

   Beef cattle comprise somewhere between 2-3% of the overall carbon-footprint of the United States (US EPA, 2019). However, global calls to action (e.g., The Paris Agreement) require an indiscriminate and significant (e.g., 30%) decreases in emissions across the board for signature countries. Across the world, livestock are being vilified in areas of academia and government. This creates irrational and long-term irresponsible actions imposed on the livestock and agricultural sector, which we have seen impact countries such as New Zealand (imposition of a tax on livestock) and Ireland (reduction).

These six principles inform management decisions and practices that <u>together</u> help build healthy

soils and, in turn, improve air and water quality, increase biodiversity and wildlife habitats, increase water infiltration and retention, reduce soil erosion, support plant and animal health, **and build vital resilience in the system**.

Challenges to Future U.S. Ranch Viability

The viability of the U.S. ranching industry is challenged by:

- soil productivity in the face of climate change;
- profitability; and
- a shrinking base of farmers and ranchers.

These challenges are a direct result of the philosophies underpinning the U.S. agriculture industry for the past 60 years. These challenges cannot be ignored. Moreover, we can no longer continue to merely treat symptoms with practices (separate from principles), seek and use technology for the sake of technology, and rely blindly on costly inputs.

To be successful, we must focus on the root of the problem. It starts with the soil.

We address ecological degradation by sharing and following principles that rebuild ecological processes and habitat from the ground up rather than focusing on specific singular species or indiscriminate management practices. Healthy soil is the cornerstone to any agricultural enterprise.

Principles over Practices: Applying the Principles

Building the soil with good grazing management is possible. It is being practiced across the nation, albeit in small numbers relative to the overall beef industry.

In properly managed grazing lands, the six soil health principles can actively build more productive, more profitable and more sustainable agricultural production systems. In fact, it is often easier to apply the soil health principles to grazing lands (rather than cultivated croplands) because the soil health principle of properly integrating livestock is already in place.

Healthy grazing lands begin with active management. This management is based on a philosophy that properly managed, grazing livestock addresses the physiological needs of the forages being grazed and contributes positively to the natural cycles of nature.

Soil health and its benefits cannot be left to chance. Intentional and active management is required, and the first step is often a grazing plan.

Grazing plans are, in essence, conservation plans for grazing lands. They include decisions for managing the plant community in view of the soil, water, air, plant and animal resources. A well-designed and well-managed grazing plan results in healthy soils and grazing plant material, proper nutrition for grazing animals, and greater livestock production at a lower cost.

There are four key elements to a grazing plan:

- carrying capacity/stocking rate,
- livestock rotation,
- utilization rate, and
- plant rest and recovery.

All of these elements must be managed together to be effective.

Carrying capacity/Stocking Rate – "Carrying capacity" is the amount of forage available for grazing animals for a specific time. Importantly, it can vary from year to year for the same area due to changes in forage production due to weather or other factors. The amount of forage produced in a given area is a function of many factors, including soil types, forage types (e.g., grasses, legumes),

pasture condition, and previous management. However, moisture and temperatures during the growing season also drive production.

Forage production is dynamic, and the entirety of the produced forage should not be fully consumed. With proper grazing management, only a portion is used and the rest is left to maintain the health and productivity of the grazing land. The portion of the forage that is allocated for grazing is called the *available* production.

"Stocking rate" is the number of animals on a given area of land over a certain period. For all practical purposes, stocking rate is a measure of the forage demanded by the livestock over a period of time. Of course, this requires consideration of specie(s), size, and needs of the consuming livestock.

It is important that the stocking rate not exceed the carrying capacity. Improper stocking of grazing lands leads to over-grazing or under-grazing, neither of which provides favorable outcomes. Over-grazing for extended periods of time leads to the degradation of the grazing land and an overall reduction in pasture productivity, soil health, and livestock production.

Grazing Rotation – A grazing rotation considers where to graze, when to graze, how long to graze, and how long to allow a grazed area to rest and recover. The purpose of a grazing rotation is to manage the impact of grazing on the grazing land while maintaining or improving livestock production.

Livestock are selective grazers. If left unmanaged, livestock tend to disproportionally graze certain plants over others. Livestock also prefer the fresh regrowth over mature leaves. In a continuously grazed pasture, plants that are grazed early in the growing season are grazed repeatedly without adequate time to recover. If plants are grazed too short for too long, these plants are not allowed to regrow leaves to supply needed energy to the roots (through photosynthesis). With impaired roots, the plant becomes less resilient and can ultimately die. Over time, the more-productive plants are grazed out leaving less desirable, less productive plants, which can lead to deterioration of the grazing land and the health of the soil.

Grazing Intensity – Grazing intensity is the amount of grass and forage removed before livestock are rotated to a new area. Stated another way, it is how short the pasture is grazed before removing the grazing animals. As but one example, consider "take half and leave half." Conceptually, this means graze the top half of the leaves and leave the rest to allow for rapid recovery and regrowth. Ideally, every plant in the pasture would be grazed evenly at this level. Taking more, negatively impacts root growth and requires additional recovery time. Grazing 50% or less (in this scenario), actually stimulates plant and root regrowth. This expedites recovery and increases the productivity of grazing lands.

The circumstances (e.g., soil health, the availability of moisture) all impact these percentages. While some ranches can support "take half and leave half," other geographies may require taking less, or maybe, in the presence of healthy soils, an abundance of soil moisture, and the right forages, animals could consume more than 50%. Again, context matters.

Rest and Recovery – After being grazed, plants need an adequate recovery period (generally, 45 to 90 days). The more severe the grazing intensity, the longer it takes for the plants to fully recover. Soil moisture and seasonal temperatures also affect the rest and recovery period. In favorable moisture conditions, the recovery period is shorter than in low moisture conditions. As moisture becomes more limiting, longer rest and recovery periods are required.

It is important to determine the recovery period based on the key species in the grazing land being managed. In a native grass pasture, the key species are those more productive, more palatable

species that have a longer recovery period than the less desirable species. Introduced pastures usually have a shorter recovery period than the native prairies and must be managed differently for optimum results.

Critically, grazing lands should not be over-rested, which removes the important aspect of grazing livestock from the land for extended periods of time beyond the recovery of the forages.

The practices and strategies of this grazing mimic how the grazing lands evolved over time with roaming herds of livestock, which yielded (without the assistance of man) some of the most abundant and lasting ecosystems on the planet.

Research Needs

Climate change is complex, and it is understood that research is needed to enhance our understanding. We need more than knowledge for the sake of knowledge.

The role of research can contribute to the knowledge and experiences of farmers and ranchers and assist them in understanding the impact of their management, offer alternatives, and contribute to their underlying economic viability. Research and its outcomes must play a part in equipping our farmers and ranchers to adapt to changing weather patterns but also address changing consumer needs, serving local markets, and building new resiliency in the soil and their operations.

This list is not exhaustive, but is representative of research needed:

- Quantify the effects of grazing management and the connections between soils, forages, and livestock across broad spatial and temporal scales.
- Evaluate the regenerative capacity of diverse grazing systems across a variety of conditions and geographies.
- Develop an evidence-based framework or index to measure ranch health that incorporates economic and ecologic measures.
- Develop practical, cost-effective farm-level carbon accounts for representative production systems across the U.S. to move toward carbon-neutral beef.
- Evaluate existing management approaches designed to reduce inputs/chemicals and their impact on profitability and grassland sustainability.
- Quantify the relationship between grazing management and socio-economic well-being and resilience in rural America.

This is not a classic agricultural research portfolio found at U.S. universities.

The effective study of grazing management at the whole-ranch or landscape scale requires not only comparison of alternative management actions but also evaluation of the ways in which these actions and biophysical processes interact and evolve over time. The temporal and spatial variation inherent in biophysical processes and their interaction with management decisions precludes direct comparisons of grazing "systems" in classical, replicated grazing experiments. All the biophysical variables in the various processes are in a state of constant flux that is influenced by history, prevailing conditions and chance and, therefore, their manifestations are unique in time and space as they are modified by ever-changing contexts and conditions. This is the real world in which our farmers and ranchers operate.

We further need a new and different approach to agricultural research, one that transcends the normative boundaries of research that is conducted within academia and simply disseminated out

to others. We need researchers who are not removed from the land, its ecosystems, or the people who manage it. For the benefit of rural America, we seek interdisciplinary, interpretative as well as analytical research that is performed in partnership with the rancher to co-produce new knowledge about productive and regenerative agriculture. In this model, ranchers and their communities are not separate from the research or the researchers themselves. They are part of the transformative process.

Producers seek research outcomes that will fuel the critical-thinking, problem-solving farmer and rancher. We seek outcomes that might allow us to mitigate risks or refine our experimentation for our own properties, animals, or markets. And we seek new knowledge and skills to arm us to manage soil productivity in the face of climate change and to achieve our financial goals. It is the path forward.

This path cannot be achieved with traditional agricultural research and/or with classic agricultural-directed government research funding programs. To be successful, research programs must focus on outcomes that drive long-term, sustainable agricultural productivity that enhances the profitably of the producer.

Universities and other academic research institutions, both in the U.S. and abroad, are ill-equipped to undertake research at a whole-ranch or landscape level. Faculty are pushed to succeed within a discipline with success being measured by grants accrued and manuscripts written. The idea of actually helping a rancher, as the land grant institution was designed, has been dwarfed by these pressures and generally forces scientists into chasing dollars. State and federal funding levels are often insufficient and inconsistent, driving research away from the critical needs of farmers and ranchers and instead toward popular or politically-motivated trends. Industry funding tends to be discipline driven and is linked to direct economic returns to the funder. The outcome is that there is always something new for the farmer to buy or implement, which quite simply continues to push output/input, disregarding the fact that natural resources and money are finite.

The opportunity exists to address these challenges with a new perspective and approach. This will require a radical shift from traditional academia. American farmers and ranchers need such a shift. We need more organizations to shift from the norm and affirm their dedication to guiding and assisting the nation's farmers and ranchers to achieve both improved soil health and profitability in equal measures, much like the work of Noble Research Institute.

Barriers to Widespread Adoption

If the problem is known and the solution is at hand, why can't significant reform involving the soil health and economic viability occur?

Farmers and ranchers that seek an alternative way are surrounded by those—industry, academia, and peers—that are entrenched in a 60-year tradition.

Our agricultural industry was designed and constructed to move low-cost, indistinguishable commodity products from the field to the consumer in the most efficient and cost effective means possible. This marginalizes the producer-entrepreneur in this industry. Moreover, this value chain is built to distribute value throughout the chain, returning less and less to the livestock producer. Technology and input providers are members of this industry, and their incentive is driven by the adoption of the latest and greatest new tools to address problems often created by the older tools.

Our universities are training producers and industry members to meet the needs of this historic agricultural industry. This impacts research (as noted above) as well as those training to be future scientists, researchers, and agribusiness professionals.

Many of our government programs do not encourage long-term land stewardship and building soil health, integration of livestock, or adaptive management. Instead, the programs prescribe a series of practices irrespective of ecological impact or consequence.

From peer farmers and ranchers, some have responded but many have not. In all fairness, the idea of soil health and our understanding of the world that lives beneath the soil is relatively new. It wasn't something ignored, perhaps, it was something that wasn't considered. Consequently, many just associate the loss of topsoil, poor productivity, and the lack of profitability with simply the status quo or something else beyond their control—bad luck or the weather.

Admittedly, conditions of the soil changed slowly and most didn't recognize that dust storms and erosion could be prevented or reduced. When some did recognize and begin to talk and write about the problem, others couldn't imagine that they were part of the problem. However, leaning again on the tools of the day, producers can employ fertilizer, herbicides, and insecticides to masks the problem for many years. Finally, for others (and really any industry faced with such dramatic alternatives), we are at a place where some just don't want to learn or believe.

Barriers to adoption are largely personal to each producer. Recent studies (Hannah Gosnell, 2019) suggest that adoption and practice of land stewardship based on soil health principles involves more than a suite of "climate smart" mitigation and adaption practices supported by technical innovation, policy, education and outreach. Rather, adoption and sustained practice involves subjective, nonmaterial factors associated with culture, values, ethics, identity and emotions that operate at individual, household and community scales.

Equipping the Stewards

We all should be dedicated to removing, mitigating or avoiding the barriers deterring the lasting use of profitable land management practices to improve soil health in grazing animal production.

This is not simply achieved through a single educational program, research initiative, or social media campaign. Rather, this is a transformative shift in continuing education, academia, peer networks, industry support, markets, and consumer expectation. At the heart of this transformation is the premise that we seek to preserve our grazing lands (and the ecological connection of land, water, plant and animal), and we seek to do so through dedicated stewardship and management for soil health.

We need to find new ways to engage multi-generational ranchers, young ranchers and first-generation ranchers—where they are and how they learn—to introduce these management practices and their lasting benefits. With knowledge comes confidence and with confidence comes application.

To create a critical mass for change, it won't be easy. But America's farmers and ranchers rarely look for easy. We will need everyone's assistance to preserve the landscapes that we have been blessed with—not for the sake of preservation, but to provide a productive and economical living for those charged as being land stewards.

Conclusion

U.S. ranching is a complex system intertwining people, soil, plants, animal, water, history, and economics. Future research must avoid reducing this system to any one of its parts but rather reflect this system as a whole, knowing that it is dynamic and ever-changing. Research outcomes should focus on providing producers with the confidence and tools they need to be ecologically and economically successful while continuing to provide quality, nutritious food to consumers, in the U.S. and abroad.

In this regard, the key to increasing system resiliency and profitability in ranching begins with adaptive management. Management of grazing lands is a dynamic process with a complex set of variables that must be taken into account. However, as the science of grazing management has evolved, innovative producers work with the natural cycles of the land with the goal of improving soil health through the application of principles. For the viability of the industry and our nation's grazing lands, more producers are needed. Thus, it is critical that we foster an environment of like-minded peers, academia, industry, and government that supports and encourages a soil health-based management of grazing lands to achieve long-term economic viability and ecological sustainability of the U.S. ranching industry. The benefits extend beyond our rural communities to impact our landscapes, our economy, our domestic food system, and the consumers that enjoy safe, nutritious food produced on our U.S. farms and ranches.