Agriculture Resilience Act of 2023

Workshop in Applied Earth Systems Management

Columbia | SIPA
School of International and Public Affairs

Columbia Climate School
Climate, Earth, and Society

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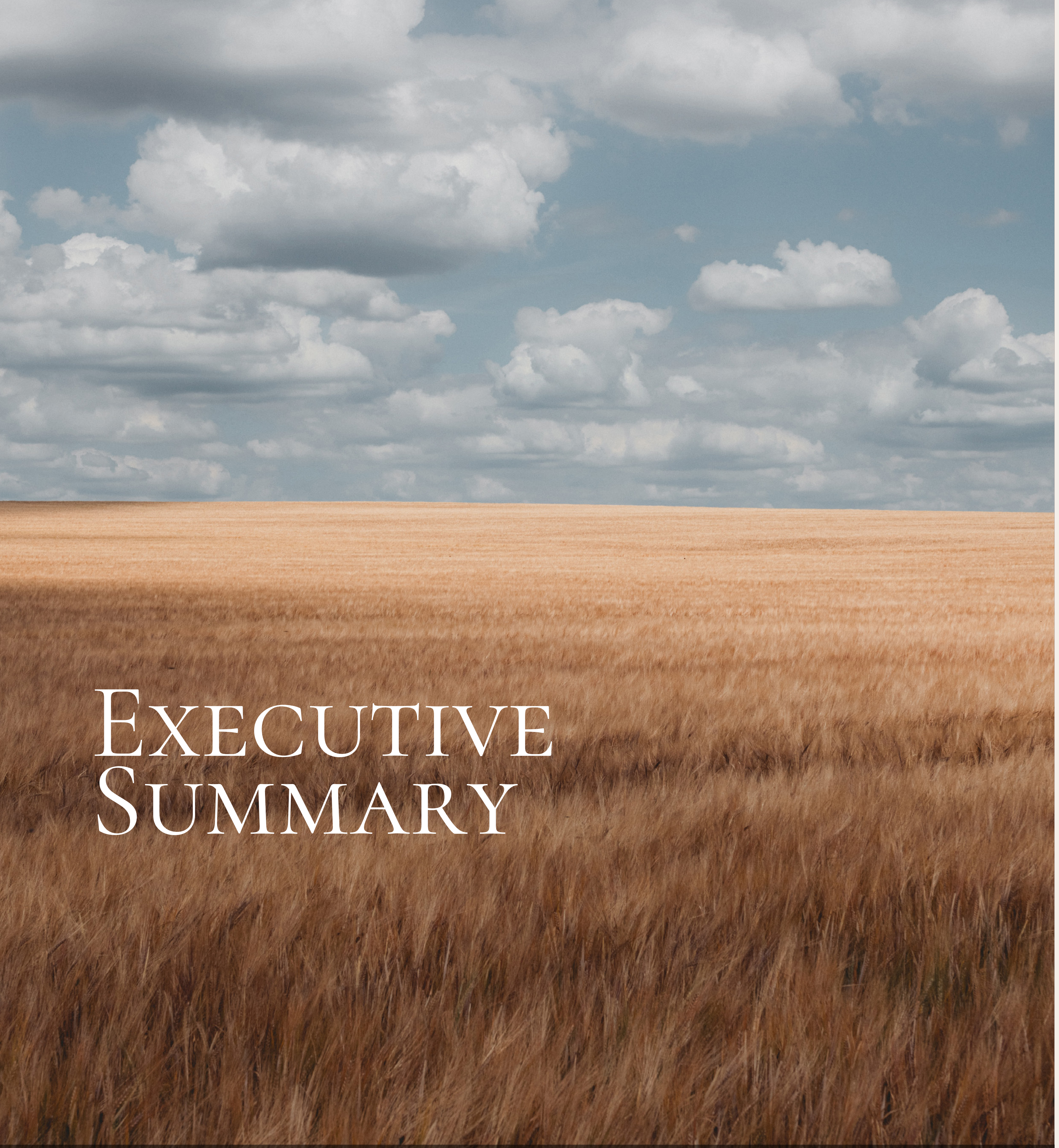


Executive Summary

American agriculture is responsible for a significant portion of total greenhouse gas emissions in the United States, and as a result, has adverse effects on the environment and accelerates climate change. Yet agriculture in the United States is also an industry that is disproportionately vulnerable to the impacts of climate change. In the United States, it is estimated that 11 percent of all greenhouse gas emissions come from agriculture, a considerable share relative to the mere 0.7 percent annual contribution of agriculture to the economy (USDA Economic Research Service, 2021). The emissions from agriculture increase the frequency and intensity of droughts, contribute to excessive rainfall and flooding, disrupt weather patterns, and create severe risks for farmers and their products.

The Agriculture Resilience Act of 2023 (hereafter, the Act) is proposed United States federal legislation introduced by Representative Chellie Pingre (D-ME). In summary, the Act aims to dramatically reduce greenhouse gas emissions from all spheres of the agriculture industry. It explicitly aims for 50 percent reduction in greenhouse gas emissions by no later than 2030, and for complete net zero emissions by 2040. The actions proposed by the Act aim to improve resilience of the agriculture sector and reduce the sector's footprint by establishing new policies across six key areas. These areas include expanding federal investment in agricultural research, expanding healthy soil practices for maximum soil carbon sequestration, promoting the preservation of viable farmlands, providing economic advantages to pasture-based livestock systems, supporting on-farm renewable energy development, and improving food waste management to reduce food loss.

To understand both the driving problems and the potential solutions to creating a more sustainable and resilient agricultural system in the United States, a team of ten Masters of Public Administration candidates at Columbia University's School of International and Public Affairs compiled research as part of a semester-long project.

This report outlines their work, which expands on the Act's Titles 3 and 5, aimed at improving soil health, reducing greenhouse gas emissions, and promoting pasture-based livestock grazing. It examines both the barriers and opportunities for increasing soil carbon stocks by 0.4 percent annually, and for cutting emissions by half from on farm soils, livestock, waste, and fossil fuel combustion within the next seven years.

Additionally, this report summarizes the controversies surrounding each proposed solution. For soil health, the value and effectiveness of tillage is widely debated, with benefits of short-term nutrient boosts for crops and drawbacks in terms of long-term soil degradation. Pasture-based grazing is also heavily disputed, as confined feeding operations are less expensive and require less inputs in terms of land and labor. Lastly, considering more sustainable diets as a means to uphold the goals of the Act was a contentious topic considered in the process of analyzing this bill.

To summarize, this bill uses policy interventions that focus on an interconnected, evidence-based, and farmer-driven approach to implement a range of financial, technical, and science-based strategies. The solutions outlined in the bill aim to simultaneously improve resilience of farmers' livelihoods in the face of climate change, while also reducing the impacts that agriculture has in propelling climate change.

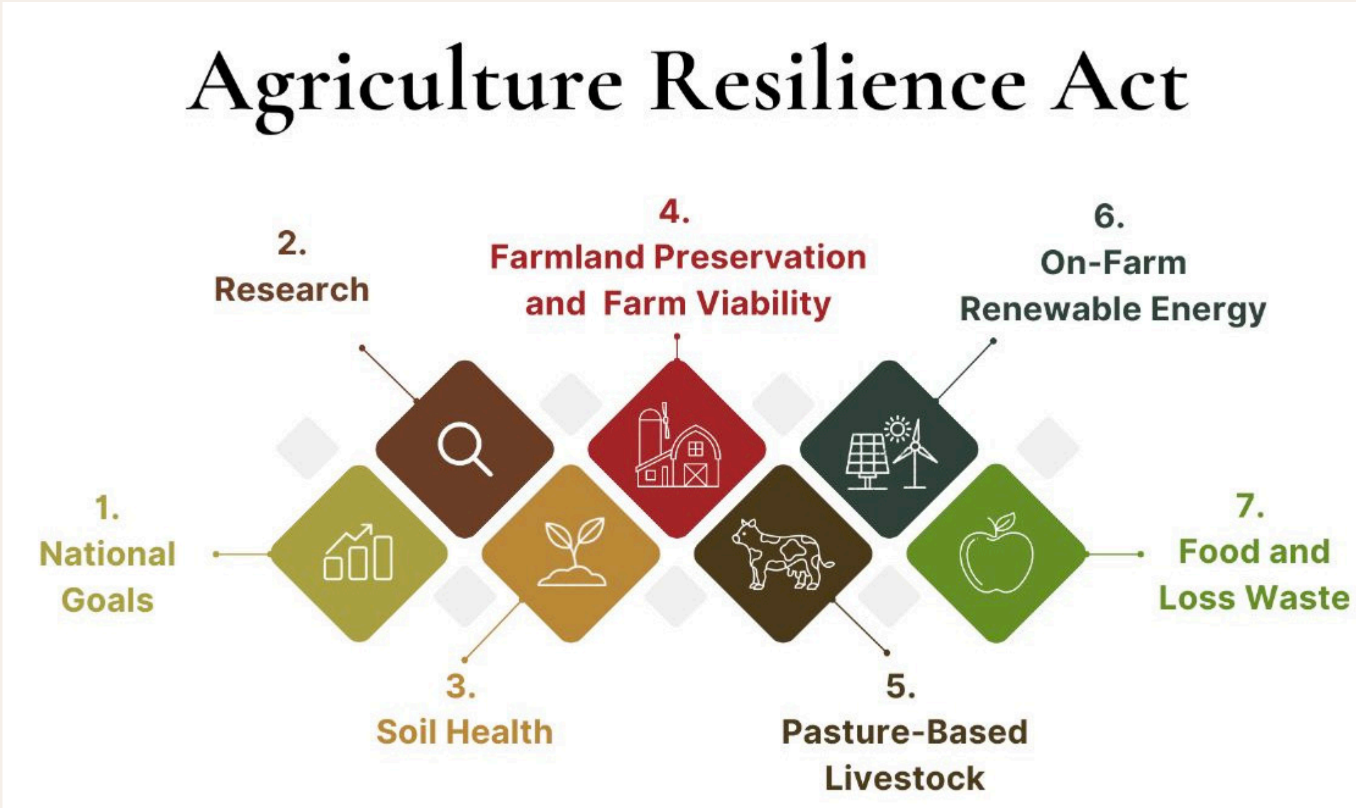
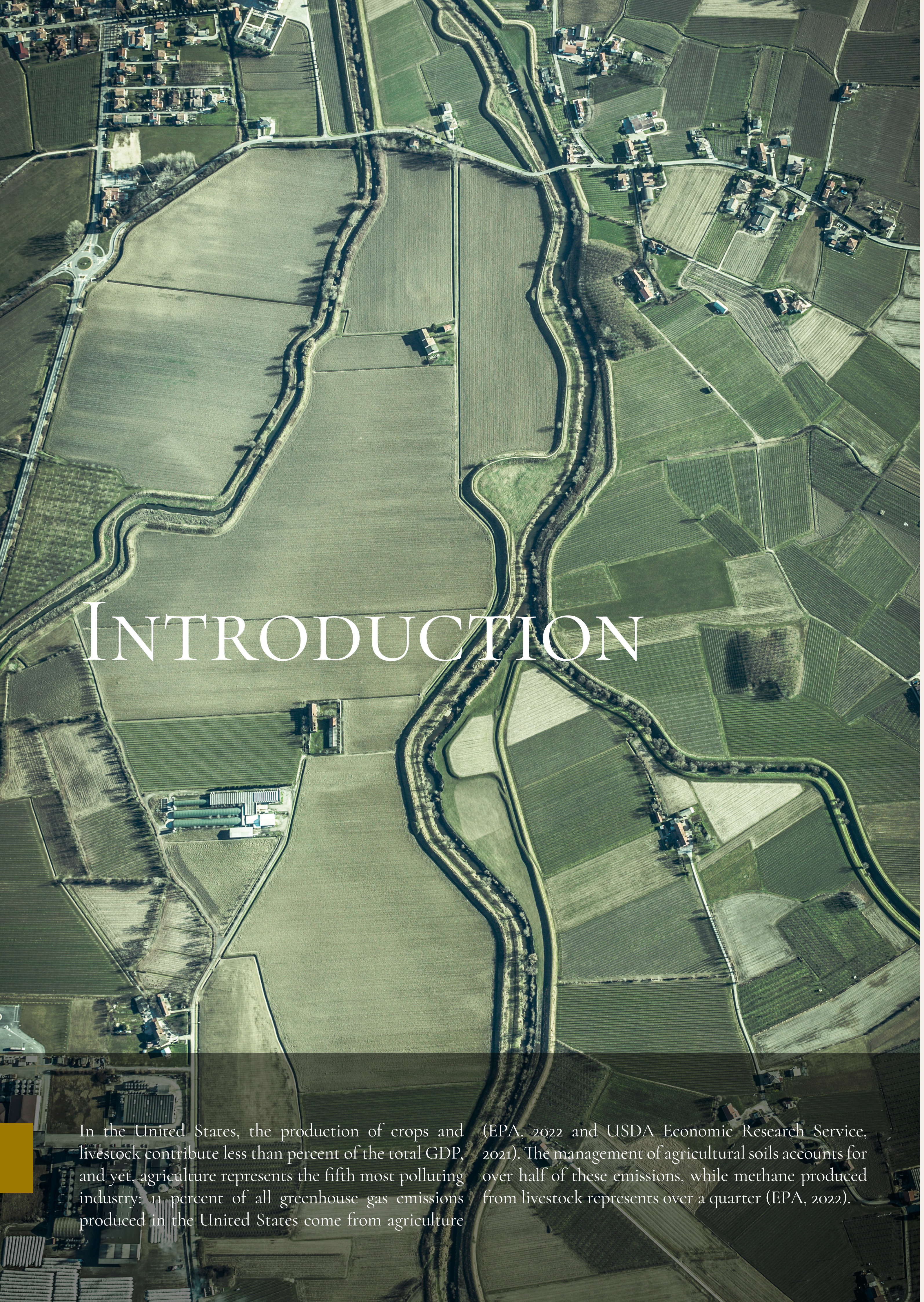


Figure 1: The Six Core Policy Recommendations



Introduction

In the United States, the production of crops and livestock contribute less than percent of the total GDP, and yet, agriculture represents the fifth most polluting industry: 11 percent of all greenhouse gas emissions produced in the United States come from agriculture (EPA, 2022 and USDA Economic Research Service, 2021). The management of agricultural soils accounts for over half of these emissions, while methane produced from livestock represents over a quarter (EPA, 2022).

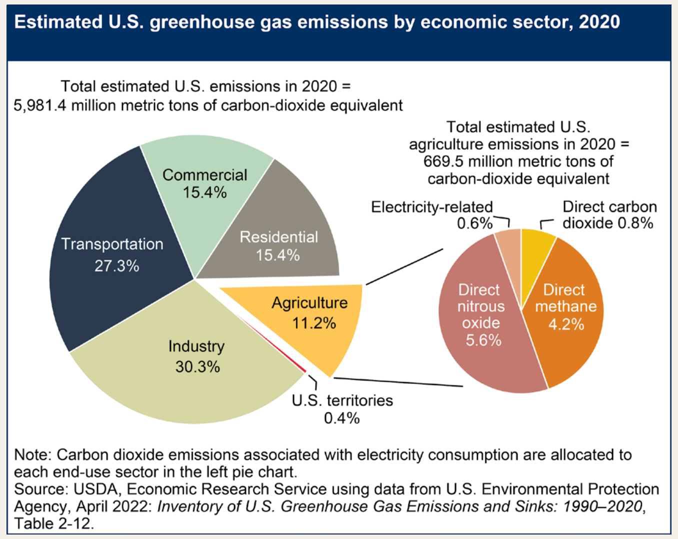


Figure 2: Estimated U.S Greenhouse gas emissions by economic sector, 2020. Source: USDA

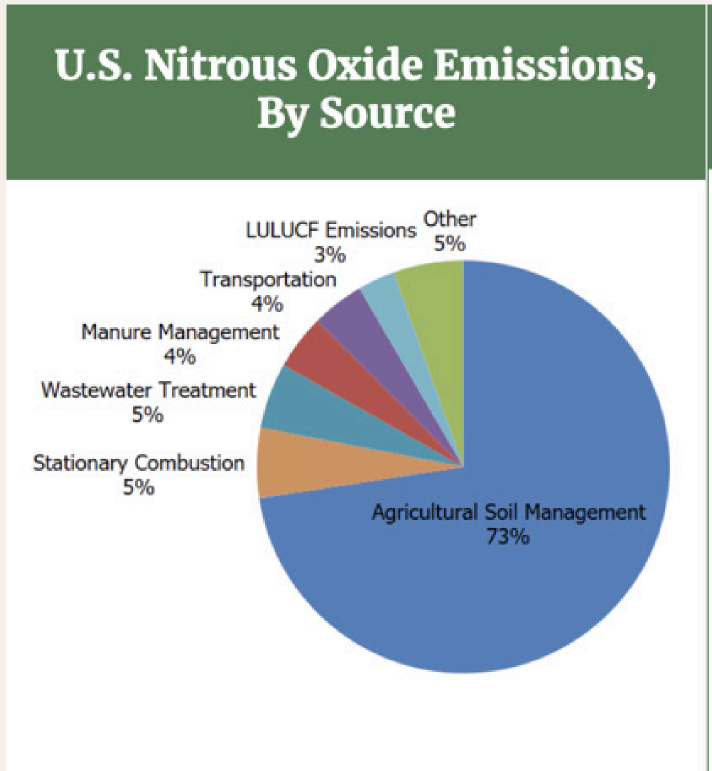
A significant portion of these emissions come from the greenhouse gasses nitrous oxide and methane gas. These two gasses result from enteric fermentation, manure management, and synthetic fertilizers (nitrous oxide) as well as from the decomposition of unconsumed foods (methane). Both nitrous oxide and methane trap heat in the atmosphere at a potency far greater than carbon dioxide, accelerating the greenhouse effect (EPA, 2023).

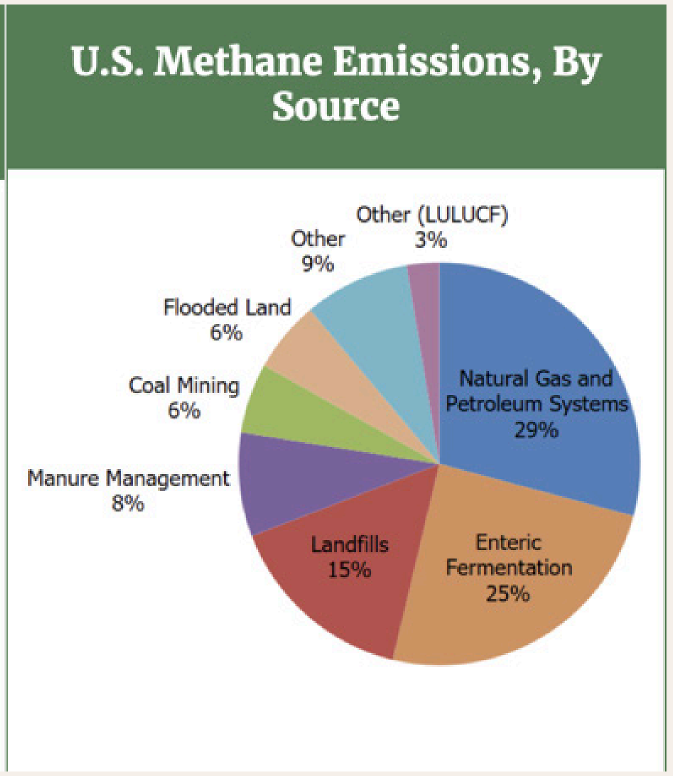
Nitrous oxide is a greenhouse gas with 300 times the warming potential of carbon dioxide (Stanford, 2020). Nitrous oxide is produced by agricultural practices such as the application of fertilizers, the management of livestock manure, burning of agricultural residues, irrigation, and the drainage of highly-organic soils (Stanford, 2020). Agricultural soil management contributes 73 percent of all nitrous oxide emissions in the United States, so improving these agricultural practices would produce significant progress in mitigating climate change.

Methane is a greenhouse gas with 25 times the potency of carbon dioxide (EPA, 2023). The majority of methane emitted in agricultural activities results from the digestive processes of domestic livestock such as cattle, swine, sheep and goats (EPA, 2022). When animal manure is stored or managed on farmland, additional methane is released into the atmosphere.

A reduction in both these greenhouse gas emissions from the agricultural sector is imperative if the United States is to reduce overall emissions.

The agriculture industry is estimated to face severe challenges in the coming years because of climate change. The National Aeronautics and Space Administration (NASA) predicts that by the middle of this century, U.S. farmers will experience heat waves at a rate 2.5 times the historic averages, an increase in flash droughts by 17 percent, and a likelihood of heavy rains occurring once every 5 years as opposed to once every 20 years (NASA, 2023). In general, northern areas of the U.S. are projected to become wetter while southern areas will experience drier conditions (NASA, 2023).





Figures 3 and 4: Inventory of US Greenhouse Gas Emissions and Sinks 1990-2021. US Environmental Protection Agency 2023.

While a major contributor to climate change, agriculture also represents an essential industry for both farmers and consumers. American food security and the livelihoods of farmers and related industries are at stake when agriculture suffers. It is projected the agriculture industry will receive some of the worst impacts of climate change, including increasing severity and frequency of storms and droughts, more variable seasonal weather patterns, and soil degradation. Without an adaptive and resilient agricultural system, climate change will likely result in long-lasting and multi-layered effects. Furthermore, building a diverse and resilient agriculture system is necessary to more equitably distribute the economic and social benefits from the agriculture industry.

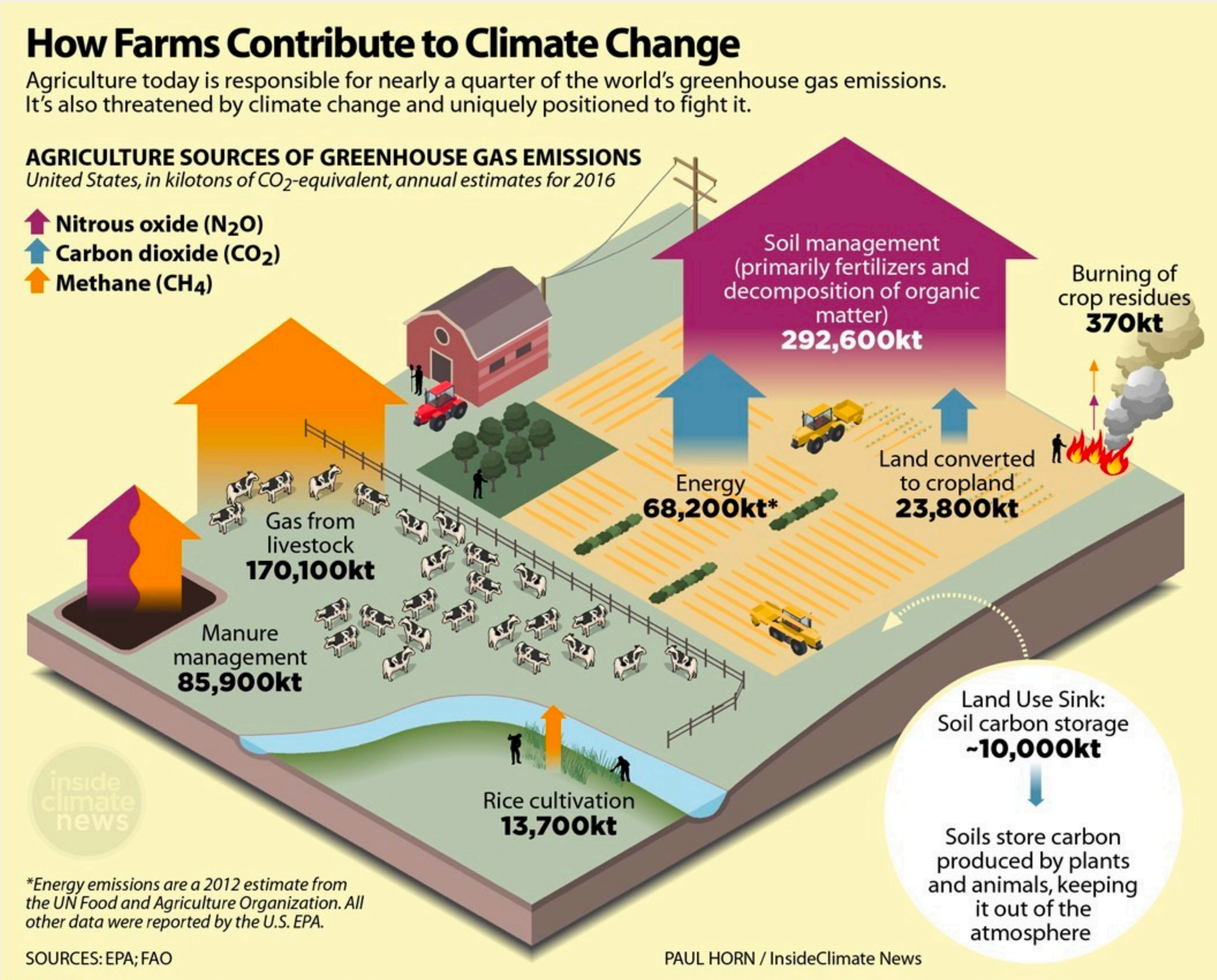


Figure 5: How variety of agricultural functions contribute to greenhouse gas emissions. Source: Paul Horn, InsideClimateNews

Soil Health

Soil health, or optimal functioning of soil physical, chemical, and biological functions, is vital both for crop and livestock production and for ecosystem functions including carbon sequestration. The Agricultural Resilience Act of 2023, in its goal to reduce net greenhouse gas emissions from agriculture, specifies a goal to increase total soil carbon stocks by 0.4 percent annually on at least 50 percent of agricultural land by the end of 2030 through improving soil management practices. This section highlights the role of soil health in environmental problems,, including the solutions proposed by the Act and the measurements of success for these solutions.

Challenges

Modern agricultural practices such as intensive tillage, overuse of chemical fertilizers, and monocropping lead to soil erosion, nutrient depletion, and loss of soil organic matter. These changes lead, in turn, to soil degradation, water pollution, and reduce the ability of the soil to sequester carbon (Lal, 2015).

Soil erosion, which is the loss of nutrient-rich topsoil, impairs nutrient and carbon cycling and diminishes agricultural productivity (Borrelli et al., 2017). Erosion occurs through natural processes like weathering from wind and water, but agricultural management practices like tillage and monocropping intensify erosion (Boguzas, 2022). Frequent tillage, for example, disrupts the soil structure, creating loose soil particles on the surface that are easily lost to wind and water (Iowa State University, n.d.). Excessive fertilizer use, which may be used to offset existing poor soil quality, can result in further soil degradation (Lin et al., 2019).

Monocropping, in which a single crop is grown at a time, leads to nutrient depletion because a single crop grown year after year uses the same nutrient profile from the soil, diminishing the pool of those nutrients over time (Balogh, 2021). Monocropping also reduces the diversity of plant and animal life that can help manage crop pests, requiring greater pesticide use. Pesticides kill beneficial soil microorganisms, damaging the processes that allow soil to retain nutrients in the first place (Center for Biological Diversity, n.d.).

Nutrient depletion and soil erosion from tillage, excessive fertilizer use, and monocropping decrease soil organic matter, which degrades the soil. Loss of organic matter reduces the storage capacity of carbon and nitrogen in soils, reducing soil fertility and agricultural productivity, as well as increasing greenhouse gas emissions and contributing to climate change. At the same time, climate change exacerbates soil health problems by altering precipitation patterns, causing further erosion and soil nutrient depletion (Gowda et al., 2018).

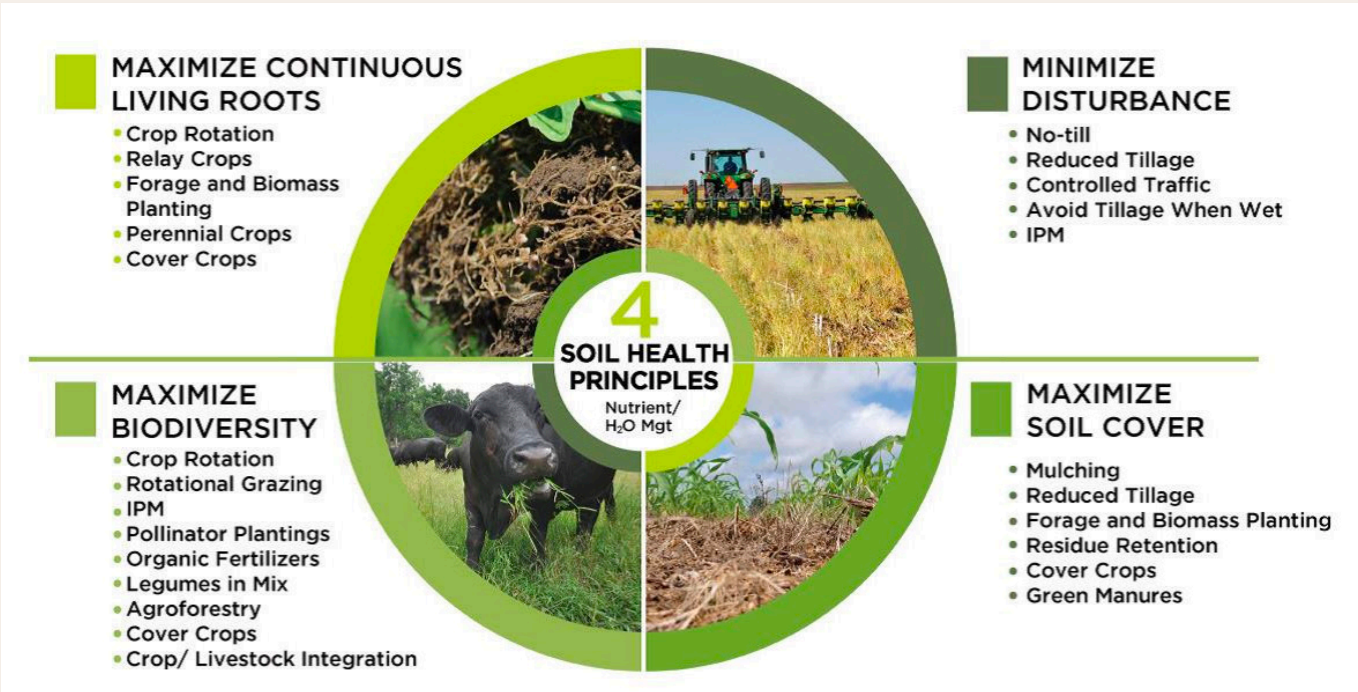


Figure 6: USDAs' Soil Health Principles and Supporting Strategies Source:USDA

Proposed Solutions

Within the overall objective to reduce carbon emissions from the agricultural sector, the Act establishes a goal to increase total soil carbon stocks by 0.4 percent annually. This would be accomplished through a number of financial incentives, program expansions, and funding measures that support soil health practices.

First, the bill proposes financial incentives to support practices that would improve soil health. These incentives reduce crop insurance premiums for implementing soil health practices, like those outlined in Figure 6, and provide grants to state and tribal governments to develop soil health conservation plans. Both financial incentives are opportunities for agricultural producers to implement soil health practices, which include measures like using cover crops, crop rotation, and rotational grazing. According to research, the Federal Crop Insurance Program currently ignores soil health practices as a risk reduction practice that can decrease the likelihood of losing crop yields (Bryant and O'Connor, 2017). Crop insurance adjustments align incentives to improve soil health practices. The grant program for states and tribes allocates $140,000,000 for FY2024-2028 and $100,000,000 from FY2028 onward to create soil conservation plans. Grants can be used for soil health planning, greenhouse gas emissions reduction planning, nutrient management planning, integrated pest management planning, agroforestry planning, and organic transition planning.

The Act would also establish a Greenhouse Gas Emissions and Carbon Sequestration Monitoring and Measurement Federal Advisory Committee, including members from across agricultural sectors. The Act would also create National and Regional Agroforestry Centers, including establishing a National Agroforestry Research, Development, and Demonstration Center at the Forestry Sciences Laboratory of the Forest Service, in Lincoln, Nebraska, along with at least three regional agroforestry centers at other locations. These agroforestry centers will support research and implementation of agroforestry techniques such as riparian forest buffers, silvopasture, and windbreaks, which can improve soil health through reduced erosion and nutrient runoff. For example, riparian buffer strips of trees and grass can reduce phosphorus and nitrogen runoff by 77 percent and 80 percent respectively (Shrestha et al, 2021).

The Act also proposes the addition of greenhouse gas mitigation and adaptation activities into the Conservation Stewardship Program (CSP). In the CSP, farmers enroll their land to receive payments from implementing soil health and wildlife conservation measures. Importantly, farmers do not have to take their land out of production, but instead can implement conservation measures on working land. The bill allocates $4 billion per year beginning FY2024 to the program. For 2023, this program was funded at $1M, so this budget allocation represents a significant increase. 70 million acres are currently enrolled, which represents 7% of agricultural land nationwide.

Finally, the Bill provides technical assistance for assisting producers in mitigating and adapting to climate change, prioritizing historically underrepresented, low-income, beginning, veteran, and female farmers. The Act provides $17,000,000 total for the period between 2024-2028 directed towards farmers who have been historically shut out from accessing USDA programs. This attempts to address the history of discrimination against farmers of color by USDA, lending institutions, and landowners in terms of program structure, lending decisions, and land sales (Congressional Research Service, 2021).

Examples of Soil Health Practices

The Act incentivizes a variety of soil health practices, which address biological, physical, and chemical dimensions. A specific example of this is adopting cover crop, as depicted in Figure 7, which is a particularly effective method for reducing soil erosion. Cover crops form a protective layer over the soil surface, acting as a shield against the erosive forces of wind and rain (De Baets et al., 2011). Additionally, the roots of cover crops enhance soil strength, which further increases the resistance of topsoil to erosion (Virginia Association for Biological Farming, 2006).

Agroforestry practices, including the use of riparian forest buffers, silvopasture, and windbreaks, are also powerful tools for soil health improvement. For example, the implementation of riparian buffer strips significantly reduces nutrient runoff from agricultural fields into water sources, thereby improving the health of downstream aquatic ecosystems (Valkama et al., 2019).

No-till farming, as illustrated in Figure 8, another practice encouraged in the Act, works by minimizing soil disturbance, promoting the growth of beneficial soil microorganisms, enhancing carbon sequestration, and preserving soil structure and organic matter (Guo et al., 2019).This method not only improves soil fertility and water retention but also leads to increased crop productivity and climate resilience (Kane et al., 2021).

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Figure 7: Cover cropping, as shown above, maintains soil cover throughout the year to prepare for the growing season. Source: USDA.

Figure 8: Cropland that has not been tilled. Source: USDA.

Case Study: Tillage Tradeoffs in North Carolina

One controversy regarding the health of soil is on the value and effectiveness of tillage. Tillage is the mechanical overturning of soils in preparation for cultivation. Normally, farmers would till the soil before planting, because tillage loosens the soil and mixes crop residue with soil particles. This stimulates the decomposition of organic matter and creates a short-term increase in mineral nutrition, providing essential elements like nitrogen and phosphorus to support newly-planted crops (Claassen, 2019). In addition, tillage controls weed growth by disturbing their root systems (Grant, 2023). Additional benefits of using tillage also include pest elimination since the process disrupts the growth and development of soil-borne larvae and insects (Grant, 2023).

However, tillage can also degrade soil health over the long-term by increasing soil compaction and soil erosion, and by stimulating decomposition that releases carbon dioxide. No-till or reduced-till agriculture solves the disadvantages of tillage. It reduces long-term, deep-layered soil compaction and reduces soil erosion by increasing soil organic matter. It also decreases the amount of greenhouse gas released into the atmosphere since tillage practices create large air pockets that facilitate microbial respiration (Mooney et al., 2021). However, practicing no-till may lead to new challenges. No-till farmlands may require more herbicide use due to the loss of ability to mechanically control weeds (Colbach & Cordeau, 2022). The productivity of certain crops, such as sweet potato, is lower in no-till or reduced tillage systems than in conventional tillage systems (Stephen et al., 2022).

In North Carolina, decisions of whether to use tillage versus no-till systems are not simple. The soil in North Carolina is dominantly sandy soil (shown in Figure 9)

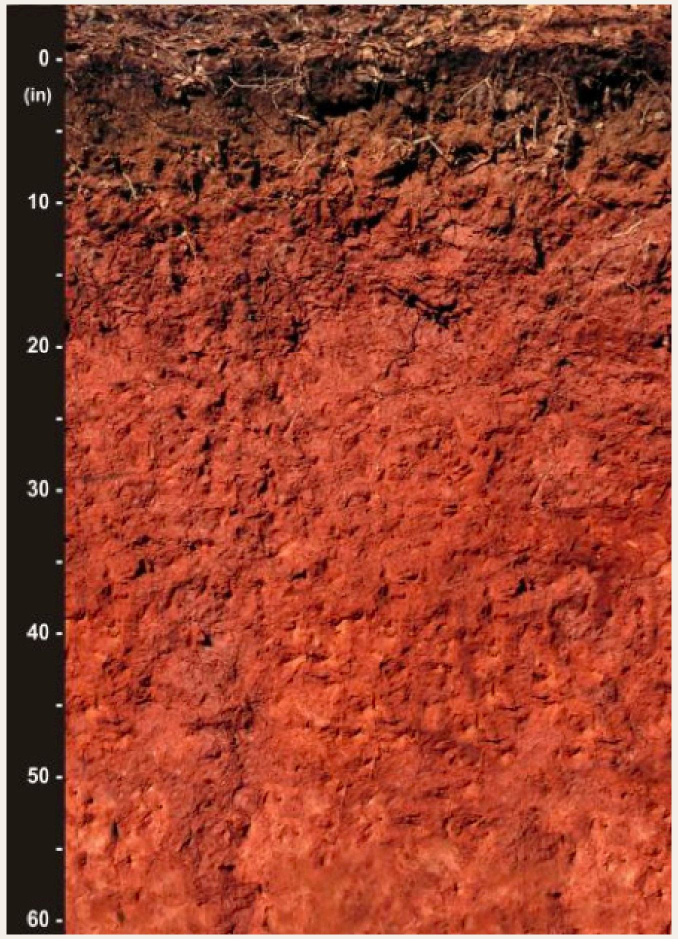

Figure 9: North Carolina's soil, characterized by a sandy layer on top. Source: United States Department of Agriculture, Natural Resources Conservation Service. 2006. Photo by Chip Clark, Smithsonian.

with a mix of coarse and fine sand particles (Carroll, 2022). With frequent rainfall in eastern North Carolina, it is hard to avoid using heavy machinery while the soil is wet. Due to the continued wetting and drying sequence and soil compaction by machinery, finer sand particles move deeper into the soil profile over time, forming a hard layer underground and therefore influencing the growth of crop root systems. Tillage can break up this hard layer, which improves root growth, but, as discussed, tillage may also reduce soil organic matter, increase soil erosion, or result in even worse soil compaction if tillage is too frequent (Carroll, 2022).

Despite these potential challenges, there are a variety of case studies of farmers in North Carolina successfully implementing no-till strategies. Russell Hedrick produces corn, soy, and specialty grains on his farm in Catwaba County, North Carolina (Figure 10). Initially, the decision to pursue no-till management was due to economic constraints - Hedrick started his farm in 2012 without money to pay for a tractor to till the land he was farming on. The farm began as 100 percent no-till, and Hedrick used cover cropping over half of his 30 acres. During his first year farming, his yields topped the county average. Since 2012, he's expanded his farm to more than 1,000 acres, with yields consistently 20 to 30 percent above county averages. The cover crop and no-till management strategies have resulted in nutrient-rich soil over time, allowing Hedrick to reduce his fertilizer use and save money on fertilizer costs (USDA, 2018).

Figure 10: Russell Hedrick, who produces crops like corn and soybeans on his farm in Catawba County, North Carolina, successfully implemented both no-till management and cover cropping on his land. He has found it to produce both high yields and financial savings due to using less fertilizer. Source: USDA.

Measuring Efficacy

In order to measure progress against the goal of increasing soil carbon content by 0.4 percent annually on 50 percent of agricultural land by 2050, developing an effective soil organic matter and soil carbon measurement program will be crucial. Soil organic matter, which is the portion of soil that is live or dead biomass, is an essential metric of soil carbon sequestration because soil organic matter is approximately 50 percent carbon (Department of Primary Industries and Regional Development, 2023). Conservation practices, as well as techniques like cover cropping and no-till management can increase soil organic matter (Sustainable Agriculture Research and Education, 2023). Infrastructure to measure the increase in soil organic matter and monitor the 0.4 percent increase per year in total carbon stocks must be scaled up.

USDA's current measurement methodology is a regional program for soil organic carbon stock monitoring in partnership with Iowa State University, Michigan State University, U.S. Climate Partners, and the University of Texas at El Paso (USDA, 2022). By investing in these selected partners, USDA is able to support soil assessment and monitoring activities and assign qualified personnel to travel to different farms collecting soil samples. Specifically, soils will be sampled using hydro-probe or excavation methods. The soil will then be tested for organic carbon and bulk weight to provide farmers and ranchers with levels of organic carbon stocks (USDA, 2022). In order to be able to monitor success for the 0.4 percent increase per year in total carbon stocks, however, this program must be expanded to all states and counties (possibly by partnering with universities in all 50 states, for example). Also, USDA is currently seeking proposals for regional projects that expand soil organic matter and soil carbon data collection, including programs that expand soil carbon measurement infrastructure across the U.S. (USDA, 2022). While not part of the Agricultural Resilience Act directly, these ongoing efforts by USDA to expand the ability to track and monitor soil organic carbon are the foundation of measuring success for the bill's soil carbon stock goals.

Greenhouse Gas Emissions and Pasture-Based Grazing

Greenhouse gas emissions from agriculture account for 11% of total U.S. greenhouse gas in 2021 (EPA, 2023). Agriculture is critical to food security, so even though economic activity and overall U.S. emissions decreased during COVID-19 in 2020, agriculture emissions did not (CRS, 2022). There are four main sources of emissions in the agriculture sector including soils, livestock, waste management, and use of fossil fuels.

Soil respiration is a fundamental process in the cycling of carbon and nutrients within an ecosystem. Soil respiration is a combination of heterotrophic respiration from the decomposition of organic matter and root respiration. Decomposition occurs when soil microorganisms break down organic matter, such as plant debris or animal remains, to release the stored chemical. This process uses oxygen and releases carbon dioxide as a byproduct. Root respiration releases carbon dioxide through the cellular respiration of living plants. Microbial respiration increases exponentially with soil temperature (Karhu et al. 2014).

Another important greenhouse gas process involving soils is denitrification, which is primarily carried out by certain groups of bacteria that convert soil nitrate into nitrous oxide and dinitrogen gas under anaerobic conditions (IPNI, 2019). Nitrous oxide is a powerful greenhouse gas, accounting for 6 percent of all U.S. greenhouse gas emissions. Agricultural soil management accounts for 73 percent of all nitrous oxide emissions (EPA, 2023). The rate and extent of denitrification are influenced by various factors, such as soil moisture, temperature, pH, organic matter content, and availability of nitrate. The application of nitrogen-based fertilizers and the use of irrigation systems can both have important effects on denitrification (PBS, 2021).

Livestock account for 40 percent of all agricultural emissions, primarily through manure decomposition and enteric fermentation within ruminant animals. Enteric fermentation happens during the digestive process in the stomach of ruminants. In the rumen, a section of the stomach, specialized microbes break down feed through fermentation, leading to the production of methane as a byproduct. This methane is later released into the atmosphere through belching and flatulence.

Agricultural waste management involves the disposal of agricultural waste byproducts, residues, and excess material. The decomposition of organic waste by microorganisms is one source of greenhouse gas emissions. Burning crops and crop residues to clear fields in preparation for the next growing season also contributes emissions. Between 1 and 3 percent of harvested land in the U.S. is burned each year (Simcox, 2022). The decomposition of unconsumed food also produces methane, carbon dioxide, and other greenhouse gases. Nearly 40 percent of all food in the United States is wasted (Feeding America, 2022).

The combustion of fossil fuels in agriculture, such as gasoline and diesel, also releases carbon dioxide and other pollutants into the atmosphere. These fuels are used in the agricultural sector to power heavy machinery, transport and process food, power cooling systems, and manufacture fertilizer. Energy use contributes nearly 10 percent of the total greenhouse gas emissions from agriculture (IPCC, 2022). Although fossil fuel burning is not as large a source of greenhouse gas emissions as those mentioned previously, it is still important to note the dependency on fossil fuels in the agricultural sector.

Land use changes associated with agriculture, such as deforestation for pasture, also contribute to carbon dioxide emissions. Collectively, these processes underline the significant role of livestock in greenhouse gas emissions and highlight the urgent need for improved practices in this sector.

Proposed Solutions

The Act provides economic advantages for converting to pasture-based livestock systems and supports farmers who adopt these processes or otherwise improve their grazing management practices. Education, research, and training will be given to support farmers who are transitioning from feedlot systems or continuous grazing to managed graze-based systems. Contracts will be awarded to eligible producers to support carbon sequestration and greenhouse gas emissions reductions from implementing alternative manure management. Alternative manure management contracts will be given to farmers who address air and water quality and public health concerns associated with dairy and livestock operations, especially those located near low-income or underserved communities.

Advanced pasture management in the form of management-intensive rotational grazing increases soil carbon content through reducing soil disturbance and compaction, reducing greenhouse gas emissions, and increasing water infiltration and plant biomass, contributing overall to greenhouse gas emissions reductions and improved soil health (Baronti et al., 2022). Currently, an estimated 97 percent of beef is produced in a feedlot (NRDC, 2014). Cattle raised on a low-grain, high-forage diet produce 42 percent less methane emissions than strictly grain-fed cattle(Wilson, 2021). Farmers implementing a transition from feedlot to pasture-based livestock would benefit from financial aid, educational resources, and technical assistance.

The Act also expands the size of the Conservation Reserve Program (CRP). The CRP encourages farmers to take environmentally sensitive lands out of production and stop farming on these lands through providing "rental" payments for 5–10-year terms. Benefits of the program include wildlife habitat improvement, water quality enhancement, and soil conservation. Removing marginal and environmentally sensitive lands from production reduces soil erosion and enhances wildlife habitats. According to the USDA, in 2017 (the most recent year in which this data is available), CRP lands prevented 192 million tons of sediment, 521 million tons of nitrogen, and 103 million tons of phosphorus runoff, and reduced greenhouse gas emissions by 44 million tons

(USDA, 2017). The Act increases the acreage eligible, types of land eligible, and provides technical assistance for improving soil health, increasing soil carbon, and creating more sustainable grazing systems.

The Act also includes provisions on manure management. This bill provides funding and technical support to implement covered manure management, pasture-based management, and solid separation systems. Covered manure management, which involves putting a layer of straw on top of manure, can reduce methane emissions by up to 15 percent; separating solid waste from liquid waste can reduce methane emissions by up to 30 percent (Dairy Farmers of Canada, 2020). The bill allocates $1.5 billion to the Alternative Manure Management Program from fiscal years 2024 through 2028. Currently, the Conservation of Private Grazing Land program is funded at $60,000,000 each year from 2002 through 2023; this bill proposes adding the Alternative Manure Management Program to the Conservation of Private Grazing Land program. The majority of funds will be allocated to small and mid-sized dairy and livestock operations.

Additionally, the physical movement of the livestock enhances soil aeration. While this can increase the rate of organic matter decomposition, it also facilitates the transformation of organic matter into a more stable form known as humus (Franzluebbers, 2007), which is

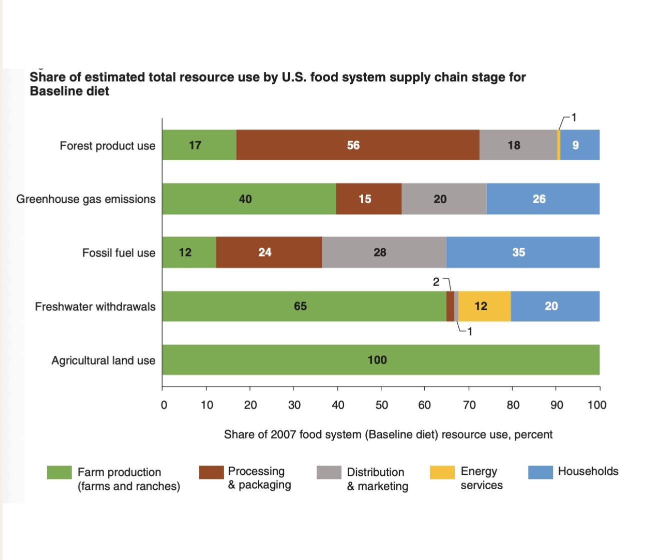

Figure 11: Resource use at each stage of the current food system supply chain. Source: USDA 2008

less prone to further decomposition. Furthermore, the trampling by animals helps incorporate both manure and plant residues into the soil, protecting some of it from rapid decomposition and contributing to the overall increase in soil organic matter. This, in turn, nurtures the activity of free-living nitrogen-fixing bacteria. (Contosta et al., 2021).

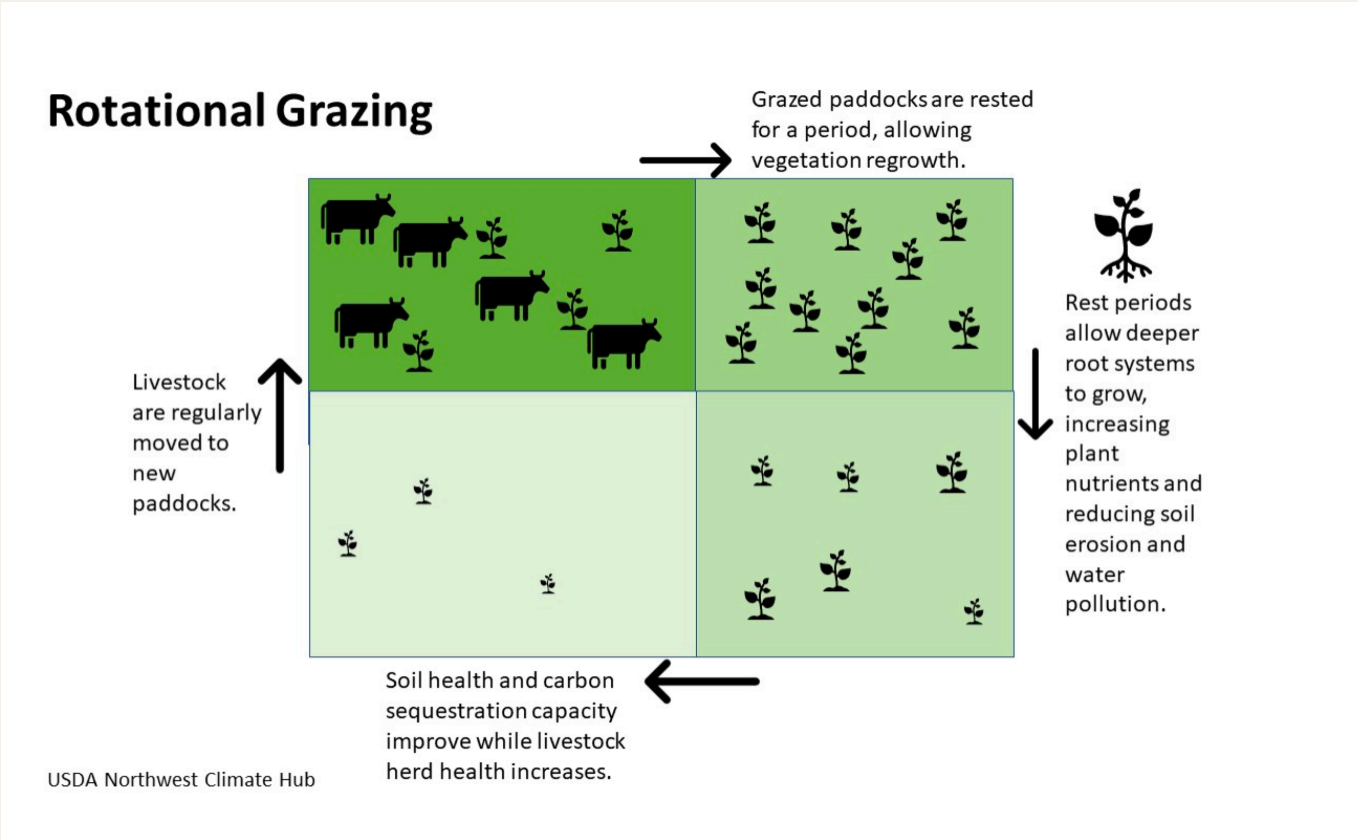

Figure 12: How rotational grazing works. Source: USDA Northwest Climate Hub

Measurement and Controversies

The Agriculture Resilience Act 2023 has set a goal to reduce GHG emissions by 50% before 2030. Actions to achieve this goal include changes in livestock feed quality, livestock types, and management practices.

The Intergovernmental Panel on Climate Change's (IPCC) Enteric Emission Model, primarily used in the U.S. (Mangino et al., 2003), considers specifics like animal types, diets, and climates to assess emissions. The model's precision comes from merging activity data, which encompasses livestock management details, with emission factors that measure emissions based on factors such as diet and environmental conditions (Solazzo et al., 2021). For the Act, the model helps evaluate the impact of livestock sector modifications on GHG emissions, factoring in changes like feed quality and livestock management. While adjusting emission factors and activity data can cut GHG emissions, the actual reduction from livestock digestion is deduced from the model and certain micrometeorological methods, introducing potential uncertainties as farms don't measure emissions directly (USDA, 2014).

Additionally, the shift to pasture-based systems carries some challenges. Pasture-based systems require more land and are more heavily influenced by seasonal change and weather conditions, making them more susceptible to climate variations (Rojas-Downing et al, 2017). They also demand complex management techniques to avoid overgrazing and maintain the health of pastures. Productivity per animal in pasture-based systems may be lower compared to confined operations due to increased energy expenditure on physical activities and variable quality of pasture feed (Rojas-Downing et al, 2017). This necessitates a larger livestock population to meet the same production targets, potentially offsetting the sustainability benefits. Increased demand for land also poses challenges. The conversion of land for grazing comes with opportunity costs – forests, wetlands, and other natural landscapes provide valuable ecosystem services that could be compromised. Moreover, pasture-based livestock products are often more expensive due to their higher production costs, reflecting a potential economic impact (Sharma et al, 2009).

Transitioning from confined feeding to a pasture-based system is a process that demands a comprehensive and gradual approach. It begins with an assessment of available resources and planning, followed by acquiring necessary education and training. Infrastructure modifications may be needed to facilitate rotational grazing and access to water. Farmers must also learn and implement effective pasture management techniques and consider transitioning to animal breeds that perform better on pastures. A health care plan for animals, a marketing strategy for pasture-raised products, and robust financial management are also vital components of this transition. The process involves continuous monitoring and adjustments. (Rojas-Downing et al, 2017)

Conclusion

The Agriculture Resilience Act of 2023 represents a strategic framework for more sustainable agriculture in the United States. The robust legislation addresses the key agricultural areas of soil health and management as well as livestock emissions. By promoting practices like no-till farming, cover cropping, agroforestry, and improved grazing and manure management, it fosters both environmental sustainability and economic viability in American agriculture. While implementation, measurement, and equity challenges exist, this Act provides a promising blueprint for reducing greenhouse gas emissions from livestock, improving soil health, and increasing pasture-based livestock practices. It represents a crucial initiative to move the U.S. agricultural sector toward a resilient and sustainable future, utilizing an interconnected, evidence-based, and farmer-driven approach

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