# Drought Impacts on Cattle Stocking Rate

# Introduction

Stocking rate represents a critical decision in grazing management, directly influencing forage utilization, ecological resilience, and the long-term sustainability of rangelands (Smart et al., 2010; Holechek, 1988). An optimal stocking rate balances forage usage with preventing overgrazing, whereas inappropriate stocking - either excessively high or low - can result in land degradation, biodiversity loss, and reduced livestock productivity (National Drought Mitigation Center, n.d.; Redfearn and Bidwell, 2017).

Dennis (2021) noted that cattle stocking rates have declined over time, with more acres now required per cow to sustain adequate grazing. Several factors contribute to this trend, including climatic variability, increased cattle weights affecting harvesting practices, and shifts in land-use driven by fluctuating crop prices. Among these, climate variability, characterized by rising temperatures and changing precipitation patterns, has become one of the primary determinants of stocking rates (Mu, McCarl, and Wein, 2013). Insufficient rainfall negatively impacts hay yields and crop residues, whereas excessive precipitation can lead to waterlogging, nutrient leaching, and a heightened dependence on irrigated feed resources. Additionally, frequent and intense drought events further complicate the relationship between stocking rates and forage availability, threatening agricultural sustainability and ecological stability (Leeper et al., 2022; Iglesias, Travis, and Balch, 2022). Given these interconnected dynamics, this study specifically examines the relationship between weather variability and cattle stocking rates.

Previous studies have investigated the connections between climate variability and cattle production. Klemm and Briske (2019) conducted a retrospective analysis of temporal and spatial distributions of beef cow populations relative to climate variability from 1978 to 2017 across the U.S. Great Plains. Their findings indicate that cattle numbers correlate positively with precipitation but negatively with temperature. Rodziewicz, Dice, and Cowley (2023) employed an econometric framework to analyze drought impacts on beef cattle management, hay production, prices, and farm incomes from 2000 to 2022. Using USDA CropScape data, U.S. Drought Monitor information, and fixed-effects panel regressions, they demonstrated that drought events reduced hay production, increased hay prices, and ultimately decreased income from cattle operations. Mu, McCarl, and Wein (2013) similarly explored adaptations by U.S. agricultural producers to climate change, focusing on land-use changes and cattle stocking rates. Their results indicated that higher summer temperatures coupled with reduced precipitation significantly decreased stocking rates, with projected declines of 10–15% under future climate scenarios due to increased temperatures and the conversion of cropland into pastureland. Ritten et al. (2010) further emphasized optimal stocking decisions on rangelands, stressing flexible management practices to mitigate financial risks posed by extreme weather and drought. While previous studies have provided valuable insights into broad climate-related economic trends, this study extends the existing literature by integrating multiple detailed drought indicators within a comprehensive econometric framework. Specifically, our analysis explicitly accounts for both immediate drought impacts, and delayed effects carried over from preceding years, simultaneously incorporating hay stock data as a measure of supplemental feeding availability. This approach enables a more nuanced and realistic assessment of drought’s influence on cattle stocking rates, capturing the dynamic responses producers adopt in managing forage scarcity.

Building upon previous research, this study utilizes USDA Census of Agriculture data in conjunction with PRISM weather data to expand the understanding of how various climate stress indicators influence stocking rates. Specifically, Potential Evapotranspiration (PET), Growing Degree Days (GDD), and Extreme Degree Days (EDD) serve as metrics to evaluate water availability, heat stress, and thermal exposure impacts on stocking decisions. Through an econometric analysis, we aim to quantify how drought frequency and severity affect cattle producer decisions and propose adaptive management strategies to enhance sustainable grazing practices.

Our findings indicate that stocking rates are strongly influenced by drought conditions and hay availability. Severe droughts reduce stocking rates by up to 18%, and hay stock exerts a nonlinear impact on stocking rates. Climate projections suggest that under moderate climate change, stocking rates decline gradually, whereas severe climate scenarios result in sharper declines and more volatility. These findings underscore the need for adaptive grazing strategies to sustain livestock production under changing climate conditions.

This paper is structured as follows: the current section is followed by a description of the data, the econometric methods, results, and a subsequent discussion. The paper concludes with final remarks and highlights relevant policy implications.

# Data

## Stocking Rate

To estimate cattle stocking rates, county-level beef cow inventory data and pastureland acreage information are obtained from the USDA Census of Agriculture for the years 1982-2017[[1]](#footnote-1) (USDA 2024). Figure 1 illustrates national trends in pastureland area and beef cattle inventory as of December of each census year. Over time, beef cow inventory has fluctuated, with notable declines observed around 1983, 2012, and 2018, while pastureland use has exhibited a steady decline.

A graph showing the growth of cattle

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**Figure 1. Annual US national beef cow inventory and pastureland data.**

Source: USDA, NASS (2024).

Stocking rate is commonly expressed in terms of Animal Units (AU) or Animal Unit Months (AUM) per unit area, where one AU represents a mature cow weighing approximately 1,000 pounds, and one AUM signifies the forage required to sustain one AU for one month (Redfearn and Bidwell, 2017). To quantify total forage demand, the total number of AUs is multiplied by the grazing duration (in months), resulting in the total AUMs required for a specified grazing period. Thus, stocking rate, expressed as AUMs per acre, is calculated for each county and year as follows:

This formula incorporates three key variables: livestock inventory, animal forage demand, and the available pastureland. Specifically, the term standardizes forage requirements based on average cattle weight and grazing duration. Adjusting forage demand by total pasture area ensures the stocking rate accurately reflects both forage availability and land capacity constraints[[2]](#footnote-2).

## Weather Data

Drought occurrence and severity are driven by complex interactions between climatic, hydrological, and ecological factors affecting water availability within ecosystems (Srivastava and Maiya, 2023). A central feature of drought is the imbalance between water supply (primarily driven by precipitation) and water demand (driven by temperature, vegetation, and atmospheric conditions). Accurately quantifying drought conditions requires metrics capturing both evaporation and plant transpiration processes (Granger, 1989). To develop comprehensive drought indicators, we estimated Potential Evapotranspiration (PET), a measure representing the maximum rate at which water could evaporate under ideal moisture conditions. PET was computed using the Thornthwaite method (Palmer and Havens 1958):

where is a monthly normative potential evapotranspiration (mm ); is the monthly average temperature (); is an annual heat index; is a monthly heat index; is a constant. To assess water balance, precipitation data is integrated with PET to calculate the water surplus or deficit for each month:

where is a monthly precipitation level (mm ).

Temperature significantly influences cattle stocking rates by affecting both pasture conditions and crop growth. While precipitation reflects moisture availability, high temperatures compound drought impacts by reducing water availability and amplifying plant water stress (Srivastava and Malix, 2023). To effectively quantify these impacts, this study incorporates Growing Degree Days (GDD) and Extreme Degree Days (EDD), widely recognized metrics for assessing thermal impacts on crops. GDD captures the accumulation of thermal time (DTT) above a base temperature, reflecting growth potential (Zhou and Wang 2018), while EDD measures exposure to extreme heat detrimental to forage productivity (Huang, Sassenrath, and Lin 2023). Following Zhou and Wang (2018), these indices are defined as follows:

where , is base temperature and is upper threshold temperature. This analysis uses critical temperature thresholds of 12°C and 31°C, based on established agricultural research (Schlenker and Roberts, 2009).

Collectively, PET, GDD, and EDD offer an integrative view of climate impacts, encapsulating water availability, thermal stress, and heat exposure. To support this analysis, we retrieve high-resolution data from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) for the period of interest. PRISM data includes precipitation, minimum, maximum, and mean temperatures, along with other weather-related variables across the United States (PRISM Climate Group, Oregon State University 2024).

## Hay Stocks

Hay stocks constitute another essential explanatory variable in this analysis, serving as a critical supplemental feed source when natural forage availability is limited by drought conditions. Reduced pasture growth during droughts restricts natural forage production, necessitating supplementary feed sources. Therefore, incorporating hay stock data enables the assessment of supplemental feeding's role in mitigating drought-induced impacts on forage availability and cattle stocking rates. This inclusion provides a comprehensive understanding of interactions among drought conditions, supplemental feeding practices, and grazing management decisions. To ensure robustness, we utilize annual nationwide hay stocks data from USDA NASS (2024) for the period of interest, enabling a detailed evaluation of supplemental feeding during forage scarcity.

## Summary Statistics

The summary statistics presented in Table 1 provide a detailed breakdown of stocking rates by U.S. geographic region[[3]](#footnote-3) across four decades (1980s-2010s), highlighting notable national and regional trends. Nationally, stocking rates increased modestly from 0.69 AUMs per acre in the 1980s to 0.88 AUMs per acre in the 2010s, reflecting an overall growth of approximately 27.5% during this period.

Regional trends exhibit considerable variability. The Northern Plains region experienced a marked decline, with stocking rates dropping from 0.80 AUMs per acre in the 1980s to 0.43 AUMs per acre in the 2010s, representing a nearly 46% decrease. Similarly, the Mountain region consistently exhibited low stocking rates, fluctuating narrowly between 0.15 and 0.20 AUMs per acre, likely indicating limitations in grazing capacity or constraints due to environmental conditions. In contrast, the Lake States demonstrated remarkable growth, increasing from 0.58 AUMs per acre in the 1980s to 1.33 in the 2020s, with a notable 40.27% increase between the 2000s and 2010s. Meanwhile, regions like the Pacific and Southern Plains showed relative stability but maintained consistently low stocking rates. The Pacific region had minimal changes (around 7%), whereas the Southern Plains experienced an overall decline of approximately 6%.

These varied regional trajectories underscore persistent geographical disparities and emphasize the complexity of factors influencing stocking rates - including forage availability, climate stress, grazing practices, and economic drivers. Understanding these patterns provides essential context for evaluating stocking rate adjustments and developing targeted management and policy responses to mitigate drought impacts and enhance agricultural sustainability.

**Table 1. Stocking rate by US geographical region, 1990-2020.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Region | Year | | | | Percent Change (%) | | |
| 1980-1989 | 1990-1999 | 2000-2009 | 2010-2019 | 1990-1980 | 2000-1990 | 2010-2000 |
| Appalachia | 1.1 | 1.4 | 1.37 | 1.43 | 27.43 | -2.01 | 3.83 |
| Corn Belt | 1.1 | 1.18 | 1.34 | 1.53 | 7.69 | 13.15 | 14.68 |
| Delta States | 1.02 | 1.12 | 1.08 | 1.22 | 9.49 | -3.22 | 13.21 |
| Lake States | 0.58 | 0.71 | 0.95 | 1.33 | 23 | 33.33 | 40.27 |
| Mountain | 0.17 | 0.2 | 0.15 | 0.16 | 12.64 | -22.6 | 2.87 |
| Northeast | 0.58 | 0.74 | 0.75 | 1.02 | 28.15 | 1.36 | 34.74 |
| Northern Plains | 0.8 | 0.7 | 0.42 | 0.43 | -12.04 | -40.48 | 1.82 |
| Pacific | 0.27 | 0.3 | 0.28 | 0.29 | 9.39 | -4.86 | 1.18 |
| Southeast | 0.97 | 1.05 | 0.93 | 1.09 | 7.93 | -11.5 | 17.29 |
| Southern Plains | 0.32 | 0.34 | 0.34 | 0.3 | 7.32 | -1.47 | -11.52 |
| National | **0.69** | **0.77** | **0.76** | **0.88** | **12.03** | **-1.68** | **15.41** |

Source: USDA NASS (2024) and authors' calculations.

# Econometric Methods

Drought impacts on stocking rates may manifest both immediately and over extended periods, reflecting short-term responses and delayed management adjustments by livestock producers. Klemm and Briske (2019) emphasize that drought effects might lag behind the actual onset of drought conditions, as ranchers’ responses and forage availability do not immediately reflect changing environmental conditions. Initially, producers may rely on hay reserves or supplemental feed to sustain their herds, temporarily delaying necessary adjustments to stocking rates. However, as drought conditions persist, the depletion of hay stocks and the rising costs of replenishment can force producers to lower stocking rates to prevent overgrazing and long-term pasture degradation. Even after normal precipitation resumes, pastures often require extended periods to recover, further prolonging the effects of drought on forage availability.

To capture both immediate and delayed drought impacts comprehensively, our analysis employs lagged climate-related variables indicative of water availability, specifically the water deficit or surplus variable . By including up to five-year lagged values of these variables, the model effectively accounts for persistent drought or surplus water conditions and their enduring influences on cattle stocking rates. To address potential multicollinearity and summarize multiple drought-related variables, we implement Principal Component Analysis (PCA) to develop a unified drought index. PCA enables the reduction of dimensionality by extracting dominant patterns across drought-related measures, thus enhancing the robustness and interpretability of the econometric analysis. Our empirical investigation utilizes a panel fixed-effects model specified as follows:

where the dependent variable is the natural logarithm of the stocking rate[[4]](#footnote-4) for county and year . The independent variables include the first principal component from PCA () reflecting drought conditions, as well as Growing Degree Days (), Extreme Degree Days (), hay stocks () and its quadratic term (). The quadratic term captures potential nonlinearities in supplemental feeding impact on stocking rates. The model also incorporates county-level fixed effects () to control for unobserved, time-invariant heterogeneity - such as soil type, topography, and geographic characteristics - thus ensuring robust estimation results. This comprehensive approach provides a robust framework to analyze how climatic factors and feed availability interact to influence stocking rates. It highlights the importance of supplemental feeding strategies and the role of climatic variability in shaping livestock management decisions.

# Results

Table 2 presents the regression results. Across all models, the coefficient of the first principal component (), derived from the lagged water surplus or deficit measures using PCA, is positive and statistically significant. This indicates that drought conditions, as measured by cumulative water availability, play a crucial role in shaping stocking rate decisions. Specifically, a one-standard-deviation increase in is associated with a 15% to 18% increase in stocking rates (AUMs per acre), depending on model specification. This result implies that during periods of improved water availability, ranchers tend to maintain higher stocking rates due to better forage productivity. This interpretation aligns with the positive and significant coefficient observed for Growing Degree Days (GDD), indicating that increased accumulation of GDD—reflective of favorable growing conditions—positively influences stocking rates. Specifically, a higher number of days with optimal temperature conditions supports pasture productivity and enables higher grazing capacities. In contrast, the coefficient for Extreme Degree Days (EDD) is consistently negative and statistically significant across all model specifications, underscoring the detrimental impact of excessive heat conditions on stocking rates. Specifically, a one-unit increase in EDD corresponds to a decrease in stocking rates ranging from approximately 3.5% to 3.7%. This finding is likely attributable to increased livestock heat stress and reduced forage productivity under extreme temperature conditions.

Furthermore, the results highlight a nonlinear relationship between hay stocks and stocking rates, as evidenced by the statistically significant linear and quadratic terms for hay stock levels (Model 5). The marginal effect of hay stocks on stocking rates depends on their quantity and is described by the following equation:

At lower hay stock levels, an increase in hay stock is associated with a decline in stocking rates, possibly reflecting producers’ reliance on hay as a substitute for grazing during periods of forage scarcity. However, as hay stock levels increase, this effect diminishes and may eventually reverse, suggesting that at higher levels, producers can sustain or increase stocking rates due to improved forage availability.

**Table 2. Regression analysis results.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | (1) | (2) | (3) | (4) | (5) |
|  | 0.1637\*\*\* | 0.1797\*\*\* | 0.1638\*\*\* | 0.1597\*\*\* | 0.1535\*\*\* |
|  |  | 0.0082\*\*\* | 0.0119\*\*\* | 0.0115\*\*\* | 0.0113\*\*\* |
|  |  |  | -0.0368\*\*\* | -0.0372\*\*\* | -0.0348\*\*\* |
|  |  |  |  | -0.0002\*\*\* | -0.0051\*\*\* |
|  |  |  |  |  | 0.000001\*\*\* |
|  | 0.65 | 0.67 | 0.67 | 0.68 | 0.68 |
|  | 0.13 | 0.18 | 0.20 | 0.21 | 0.22 |
| N | 16,116 | 16,116 | 16,116 | 16,116 | 16,116 |

Source: Authors’ calculations.

Note: \*\*\* p < 0.01, \*\* p < 0.05, and \* p < 0.10.

While the full five-year-lag model captures the cumulative effect of drought over multiple years, comparing models with fewer lagged years helps illustrate how drought effects evolve over shorter periods. Table 3 summarizes regression results for models incorporating one to five lagged drought years, evaluating the cumulative impacts of drought conditions (represented by the first principal component PC1) along with other key variables.

**Table 3. Regression results for delayed drought effects.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | 1 Lag | 2 Lags | 3 Lags | 4 Lags | 5 Lags |
|  | 0.1538\*\*\* | 0.1572\*\*\* | 0.1692\*\*\* | 0.1656\*\*\* | 0.1535\*\*\* |
|  | 0.0100\*\*\* | 0.0111\*\*\* | 0.0110\*\*\* | 0.0111\*\*\* | 0.0113\*\*\* |
|  | -0.0257\*\*\* | -0.0267\*\*\* | -0.0260\*\* | -0.0301\*\*\* | -0.0348\*\*\* |
|  | -0.0044\*\*\* | -0.0042\*\*\* | -0.0052\*\*\* | -0.0047\*\*\* | -0.0051\*\*\* |
|  | 0.0000\*\*\* | 0.0000\*\*\* | 0.0000\*\*\* | 0.0000\*\*\* | 0.000001\*\*\* |

Source: Authors’ calculations.

Note: \*\*\* p < 0.01, \*\* p < 0.05, and \* p < 0.10.

Across all lag specifications, the coefficient for PC1, representing cumulative drought severity, is consistently positive and statistically significant. This result underscores the persistent and significant influence of prolonged drought conditions on cattle stocking rates over time. Additionally, coefficients for Growing Degree Days (GDD), Extreme Degree Days (EDD), and hay stocks remain statistically significant across all specifications, further reinforcing the robustness of these results. The consistency of these coefficients across lag specifications indicates that the effects of drought persist, rather than being limited to a single year.

It is important to note that we cannot distinctly identify which specific year of drought contributes most to the observed effects, as our approach captures only the cumulative impact across multiple lagged years. Nevertheless, the findings strongly indicate that lagged drought effects exist and significantly influence grazing systems. However, to fully understand the role of individual years and their contributions to the cumulative impact, future studies must address these gaps. Collecting more granular annual data on stocking rates, as well as additional contextual variables, would help disentangle the effects of specific drought years.

## Stocking Rate Projections

This study employs climate projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6), obtained via the Earth System Grid Federation (ESGF) data portal. The dataset includes simulations under Representative Concentration Pathways (RCP) 4.5 and 8.5, representing moderate and high-emissions scenarios, respectively. These projections are derived from the CanESM5 (Canadian Earth System Model version 5), developed by the Canadian Centre for Climate Modelling and Analysis (CCCma), and have been downscaled for regional analysis (Earth System Grid Federation, 2025).

RCP 4.5 assumes a stabilization pathway in which radiative forcing is maintained at 4.5 W/m² by 2100 through mitigation measures. In contrast, RCP 8.5 follows a high-emissions trajectory, leading to 8.5 W/m² radiative forcing, assuming continued reliance on fossil fuels with minimal mitigation efforts. This study incorporates key climate variables, including monthly precipitation (pr), minimum temperature (tasmin), and maximum temperature (tasmax) from 2020 to 2099, to derive agroclimatic indices such as Growing Degree Days (GDD), Extreme Degree Days (EDD), and potential evapotranspiration (PET). To account for inter-model variability, multiple realizations within CMIP6 are analyzed, enabling an ensemble-based assessment of stocking rate projections under different climate scenarios.

A graph showing the growth of the stock market

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**Figure 2. Projected cattle stocking rates (2020-2099).**

Source: Earth System Grid Federation (2025) weather projections

Figure 2 presents projected cattle stocking rates across the United States from 2020 to 2099 under RCP 4.5 and RCP 8.5, based on CMIP6 climate projections from the ESGF. The results reveal distinct trajectories under each scenario, highlighting the differential impacts of climate change on grazing systems.

Under RCP 4.5 (blue line), stocking rates exhibit a moderate increasing trend throughout the century, with periodic fluctuations. This suggests that stabilized radiative forcing, coupled with potential precipitation increases, supports relatively stable forage availability, allowing for a gradual rise in stocking rates. Conversely, RCP 8.5 (red line) follows a divergent trajectory - starting lower than RCP 4.5 but steadily increasing over time. This trend challenges conventional expectations that extreme warming and intensified drought under RCP 8.5 would reduce stocking rates. The late-century acceleration observed under RCP 8.5 may result from regional climate shifts, increased precipitation, or model variability influencing forage production estimates.

These findings underscore the uncertainties in climate projections and their implications for long-term grazing management. Future research should explore the role of precipitation seasonality, forage quality shifts, and extreme temperature events to refine stocking rate projections under different climate trajectories. Expanding the analysis to include additional realizations and ensemble-based modeling approaches could further enhance the robustness of these projections.

# Discussions

The results of this study provide valuable insights into the complex relationships between climate variability, hay stock, and cattle stocking rates. Our findings confirm that both favorable and extreme weather conditions, along with forage availability, play a critical role in determining the stocking capacity of pastureland. These results align with prior studies that have identified climate as a key driver of grazing management decisions (Klemm and Briske, 2019; Mu et al., 2013). However, this study adds specificity by quantifying the direct effects of water deficits, temperature extremes, and forage availability on stocking rates.

The results are consistent with Rodziewicz et al. (2023), who found that extreme weather events often lead to herd reductions and economic strain on ranchers. While previous studies broadly examine climate variability’s impact on livestock production, this study provides a more detailed assessment by evaluating the persistence of drought effects over time using lagged drought variables. The use of multiple realizations strengthens the robustness of these findings, ensuring that projections capture a range of possible climate outcomes.

A key trend observed in this study is the long-term decline in stocking rates under both RCP 4.5 and RCP 8.5. The steady decline under RCP 4.5 suggests that, despite mitigation efforts, climate stressors will continue to challenge grazing systems. In contrast, the sharper early-century decline under RCP 8.5 highlights the risks associated with extreme warming and drought under a high-emissions scenario. However, the unexpected late-century increase in stocking rates under RCP 8.5 may reflect shifts in precipitation regimes, temperature fluctuations, or model-specific variability that temporarily improves forage conditions in certain regions.

## Policy implications

The findings of this study reinforce the importance of adaptive grazing practices that account for delayed drought impacts. Policies should incentivize ranchers to adopt strategies such as flexible stocking rates, rotational grazing, and pasture resting periods, which can help mitigate long-term pasture degradation and support recovery after drought events. Providing financial incentives or technical assistance for ranchers who implement these practices can help bridge the gap between short-term economic pressures and long-term sustainability goals.

Programs like the USDA’s Livestock Forage Disaster Program (LFP) have demonstrated their value in mitigating the immediate economic impacts of drought on ranchers. However, projections indicate that with increasing drought frequency and intensity under the high-emissions RCP 8.5 scenario, federal expenditures on such programs are likely to rise significantly. Policymakers should consider refining eligibility criteria and payment structures to enhance the program's fiscal sustainability while ensuring that assistance reaches the most affected regions. Additionally, integrating disaster assistance programs with broader climate adaptation frameworks, including early-warning systems and localized weather projections, can further strengthen the resilience of livestock systems.

Another key area for policy intervention is the management of forage and hay stocks. This study highlights the diminishing marginal returns of hay stock during prolonged drought periods, emphasizing the need for efficient hay management practices. Policymakers should incentivize investments in hay storage infrastructure, forage improvement programs, and market mechanisms to stabilize hay prices. These measures can help reduce the economic burden on ranchers and prevent overreliance on supplemental feeding, which is often unsustainable during prolonged drought conditions.

Overall, these findings underscore the necessity of proactive climate adaptation strategies in the livestock sector. As climate variability continues to pose challenges for grazing systems, policy-driven investments in sustainable rangeland management, climate forecasting, and economic support mechanisms will be crucial to ensuring the long-term viability of livestock production.

# Conclusion

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1. The Census of Agriculture reports come out every 5 years. [↑](#footnote-ref-1)
2. For example, suppose a pasture is used to graze 50 animals, each weighing 1,200 pounds, for six months. Assuming a standard AU represents 1,000 pounds, each animal equates to 1.2 AUs. If the pastureland is 100 acres, the stocking rate is 3.6 AUMs per acre. [↑](#footnote-ref-2)
3. Regions are grouped based on shared geography, climate, and agriculture. The Lake States (Michigan, Wisconsin, Minnesota) focus on dairy and forage, while the Corn Belt (Iowa, Illinois, Indiana, Ohio, Missouri) leads in grain and livestock feed. The Northern and Southern Plains emphasize beef cattle, with differences in grazing and irrigation. The Delta States and Southeast combine crop cultivation and cattle operations, while Appalachia supports small-scale farming. The Northeast features diversified farming and dairy, the Mountain region specializes in large-scale grazing, and the Pacific excels in diverse, high-value agriculture, with California pivotal for irrigated forage and beef cattle production. These regional adaptations highlight the diversity of U.S. agriculture. [↑](#footnote-ref-3)
4. The log transformation of the stocking rate is employed primarily for two reasons. First, interpreting coefficients from logged dependent variables in percentage terms provides intuitive and easily comparable insights into how explanatory variables influence stocking rates. Second, the log transformation mitigates potential heteroskedasticity by stabilizing the variance of residuals, especially beneficial when the dependent variable demonstrates a right-skewed distribution. Additionally, the log transformation helps normalize the distribution of stocking rates, further improving the robustness of econometric estimations. [↑](#footnote-ref-4)