5 "R's" and a "W"

Round-up of Recent Range Research Relevant to Wyoming

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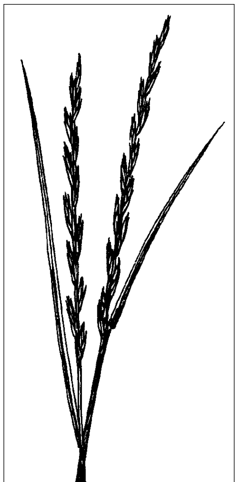
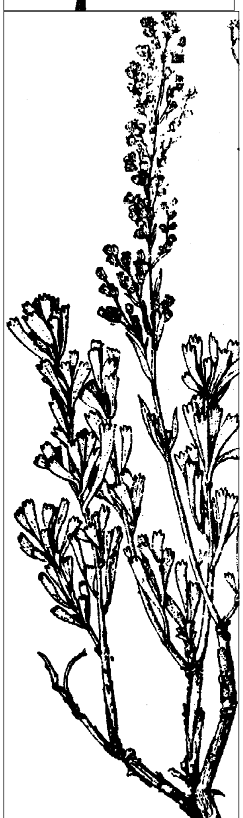


Rotational Grazing on Rangelands:

Perception vs. Experimental Evidence

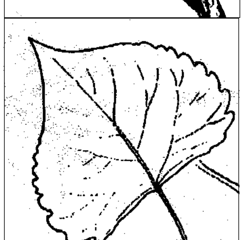


About 30 years ago, the concept of rotational grazing was introduced to North America and became a major topic for almost anyone involved with management of rangelands. Lots of ranchers, personnel from land management agencies and university range scientists were excited by the concept because it seemed to solve some classic range management problems while improving the efficiency of forage harvest by grazing animals.

Central to the concept are the ideas that livestock should be concentrated at high stock densities in smaller pastures for short grazing periods and rotated rapidly through many small pastures. Higher stock densities in smaller pastures were said to achieve more uniform livestock distribution and forage utilization. Short grazing periods also seemed to control the intensity of grazing and to allow adequate periods for rest and re-growth of grazed plants without the yearlong deferments required by some other popular grazing systems.

Allan Savory and Stan Parsons, among other early proponents, stated that such intensive management would allow dramatically increased over-all stocking rates while actually improving rangeland health. Savory initially advocated that producers immediately double their stocking rates over those commonly recommended by agencies like NRCS because he claimed that "animal impact" and rest periods would improve water infiltration into the soil, stimulate growth of desirable plants, etc. All of these ideas were highly attractive to many people. It has taken decades for research to thoroughly test these ideas and to separate hyperbole from scientific evidence.

The Verdict's In



According to the Society for Range Management (SRM), the primary organization of range professionals, the jury is no longer out. Since the 1980's, 100 or so research projects have studied various aspects of the rotational grazing concept. Nine of the world's imminent range scientists were invited by SRM to write an article that reviewed all of the scientific studies on rotational grazing and summarized their most important and consistent results. The SRM's "Synthesis Paper" on Rotation Grazing has been published in the current (Jan. 2008) issue of Rangeland Ecology and Management (formerly The Journal of Range Management). (**Continued on next page)**

Rotational Grazing Synthesis Continued:

Introduction: The Grazing System Dilemma -

In general, grazing systems are designed to increase production of key plant species and/or to enable livestock to harvest available forage more efficiently. These goals can only be accomplished by ensuring that key plant species capture the resources they need (water, light, nutrients) to enhance their growth.

Grazing systems purport to increase composition and production by: 1) ensuring key species a rest during the growing season, 2) reducing animal selectivity by increasing stock density (animals/unit of land) to overcome problems such as "patch grazing", and 3) to ensure more uniform animal distribution through improvements such as water distribution and fences. Grazing systems are defined as grazing management that defines reoccurring periods of grazing, rest and deferment for two or more pastures.

The authors of the SRM "Synthesis Paper made a very strong and unambiguous statement that also expresses the frustration that many scientists feel with regard to the issue: ***"The preponderance of evidence generated from grazing experiments over the past 60 years has consistently indicated that rotational grazing is not superior to continuous grazing on rangelands. ...Yet, in spite of clear and consistent experimental evidence demonstrating that rotational grazing and continuous grazing have similar effectiveness on rangelands, rotational grazing continues to be promoted and implemented as a superior grazing system. Strong perceptions must exist to maintain advocacy for rotational grazing systems over continuous grazing in the presence of overwhelming experimental evidence to the contrary."***

Primary Sources of Complexity and Confusion -

Ecological complexity and variability is a major problem in sorting out the relative effectiveness of rotational vs. continuous grazing. Consider the wide range in variation in critical factors such as 1) rainfall regime (amount, seasonality, annual variability), 2) vegetation structure, composition and productivity, 3) prior land use, 4) livestock characteristics (breeds, prior conditioning, care and handling). Combine those variables with the hard-to-quantify differences in the human management...commitment, ability, goals (i.e. production vs. conservation) and opportunities (i.e. land ownership, alternative revenue sources of managers operating those systems). A more complex management scheme may attract more skilled and committed managers. A well-managed rotational system is likely to achieve desired production goals more effectively than poorly managed continuous grazing. However, if the skilled and committed management is applied to the continuous grazing situation and the rotational management situation is poorly managed, the results may also be reversed.

To quote the authors, ***"In spite of this tremendous variability, <u>stocking rate</u> has emerged as the most consistent management variable influencing both plant and animal response to grazing… ...This intuitively leads us to the conclusion that management commitment and ability are the most pivotal components of grazing system effectiveness and that grazing systems do not possess unique properties that enable them to compensate for ineffective management, (i.e., grazing systems do not provide a "silver bullet" to ensure attainment of desired goals)."***

Vegetation Responses to Grazing -

Several unifying principles of vegetation response to grazing were summarized because they shaper our perception of the purported benefits of grazing systems:

1) **Chronic, intensive grazing is detrimental to plan growth** because it removes leaf area that is necessary for photosynthesis. Reduction of photosynthesis expresses itself in all aspects of plant growth and function. Chronic, intensive reduction of leaf area impacts root systems, which in turn reduces the ability of severely grazed plants to effectively access soil water and nutrients.

Vegetation response principles continued — Rest and deferment is the opposite of this principle (that chronic intensive grazing is detrimental). Periodic cessation of grazing, especially during periods of rapid growth, will enhance recovery of root and above-ground growth by promoting the recovery and maintenance of leaf area. Rest and deferment to promote plant growth is the most fundamental and long-standing principle and it is the central assumption of all grazing systems.

2) **Primary plant productivity can be increased by lenient grazing and decreased by severe grazing.** Grazing was assumed to have a negative effect of plant production for most of range management history. However, in the 1970's, ecologists introduced the "grazing optimization hypothesis." This hypothesis supposes that plant production increases above that of ungrazed vegetation as grazing intensity increases to an optimal level (compensatory growth). Production decreases at intensities beyond the optimum. However, in 80% of the studies, grazing was too intensive and plants didn't have enough recovery to promote compensatory growth. Therefore, in most cases, primary production decreases with increased severity of grazing compared to ungrazed communities.

3) **Forage quality is often improved by frequent grazing.** Forage quality determines the amount of energy and nutrients that grazing animals can acquire from eating forage. Quality varies with several well-recognized plant characteristics. Tissue age (ex. tender, succulent early-season growth vs. tougher late-season growth), tissue type (ex. Leaves vs. stems or flowerheads), functional plant group (grass, forb, shrub etc.), and anti-quality agents (lignin, cellulose, secondary chemicals). These characteristics affect forage quality by influencing the ratio of soluble components (amino acids, proteins, lipids, starch and sugar) to structural compounds (cellulose, lignin, silica, etc.). Tissues with the highest soluble to structural ratio have the highest forage quality and are usually those most preferred by grazing animals. Secondary compounds (ex. Alkaloids, tannins and other toxins) reduce the quality of forages, but are generally more of a problem in dicots (forbs and shrubs) than in monocots (grasses and grass-like plants). Generally, the ratio of soluble to structural components decreases as tissues age during the growing season.

   Frequent grazing improves forage quality because it increases the proportion of younger plant tissues with the higher soluble to structural ratios. This explains patch grazing where animals repeatedly graze the same area to get the younger, higher quality forage even though there is less total forage to be harvested in the patches.

   Forage quality is an important factor in the design and implementation of grazing systems and it is influenced by the length of both grazing and rest periods. In a study of a South African rotational grazing system, animal performance (weight gain, etc.) declined linearly as the length of either the grazing period or the rest period increased. A long rest period or a low grazing pressure allows plant tissues to mature and forage quality to decrease compared to more frequent grazing intervals.

4) **Species composition of plant communities can be modified in response to frequency, intensity and seasonality of grazing.** Grazing causes changes in species composition because animals typically graze some species more than others. This reduces the photosynthetic capacity of the more heavily used species and puts them at a competitive disadvantage. Unequal grazing pressure is recognized in the concept of "decreaser," "increaser" and "invader" groups of plants in terms of their response to grazing.

   Usually there is diversity in native rangeland plant communities, especially in large pastures. Vegetation often grows in patches based on soil, water and other variables, including grazing. These patches effect grazing and vice versa.

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Rotational Grazing Synthesis Paper Continued:

The fundamental questions are: Do the principles of vegetation response to grazing determine that rotational grazing is superior to continuous grazing? If not, why not?

RESULTS OF EXPERIMENTAL GRAZING RESEARCH

Comparison of continuous, season-long grazing and rotational grazing have now been conducted in numerous rangeland ecosystems worldwide, especially in the United States and South Africa. The authors of this Synthesis Paper compared these peer-reviewed research studies with regard to two variables, **plant production** (i.e. standing crop biomass) and **animal production** (on both a per head or per unit area basis). Geographic location, ecosystem type, relative stocking rate, and number and size of pastures for each investigation were also noted and considered. (Recall that Savory, Parsons and others often advocated stocking rates of 1.5 to 2 times higher for rotational grazing systems and that recommendation was incorporated into and was tested by some of the studies.)

Plant Production: There were no statistically significant differences in plant production/standing crop between rotational and continuous grazing in 89% of the studies (17 or 19) when stocking rate was similar. When stocking rate was less for continuous than rotational grazing, 75% of the experiments (3 of 4) reported either no differences or greater plant production for continuous grazing. Across all stocking rates, 83% of the experiments (19 of 23) reported no differences for plant production between rotational and continuous grazing, 13% (3) reported greater plant production for rotational compared to continuous grazing and one experiment (4%) reported greater production for continuous grazing.

Animal Production: Fifty-seven percent of the experiments (16 of 28) reported no differences in animal production per head between rotational and continuous grazing with similar stocking rates, and 36% (10) reported greater per head production for continuous grazing. When stocking rate was less for continuous than rotational grazing, 90% of the experiments reported either similar or greater per head animal production for continuous grazing. Across all stocking rates, 50% (19 of 38) of studies reported no differences for animal production per head between rotational and continuous grazing, 8% (3) reported greater production for rotational grazing, and 42% (16) reported greater production for continuous grazing.

Fifty-seven percent of experiments (16 of 28) reported not differences for animal production per unit land area between rotational and continuous grazing with similar stocking rates, and 36% (10) reported advantages for continuous grazing. When stocking rate was less for continuous than rotational grazing, 75% (3 of 4) reported greater animal production per area for rotational grazing. Across all stocking rates, 50% (16 or 32) of the experiments reported no differences for animal production per land area between rotational and continuous grazing, 16% (5) reported greater production for rotational grazing, and 34% (11) reported greater production for continuous grazing.

"These experimental results conclusively demonstrate that rotational grazing is not superior to continuous grazing across numerous rangeland ecosystems, and they are consistent with those of previous reviews. These results further corroborate the long-standing conclusions that stocking rate and weather variation account for the majority of variability associated with plant and animal production on rangelands."

WHY IS ROTATIONAL GRAZING NOT SUPPORTED BY EXPERIMENTAL DATA?

Rotational grazing systems are specifically designed to: 1) redistribute grazing pressure in time and space for any given stocking rate, 2) provide greater managerial control over frequency, intensity and uniformity of plant defoliation by modifying the length of grazing periods. **(Continued next page)**

Why does the redistribution of grazing pressure, which translates into periodic rest or deferment among pastures, not have more beneficial effect on plant production? The authors of the Synthesis Paper identified two broad responses to this question.

Presumed Benefits of Rotational Grazing Were Overextended—

Experimental evidence indicates that defoliation is not always controlled more effectively in rotational grazing systems than in continuous grazing, and that forage quality and quantity are not consistently and substantially increased in intensive systems compared to continuous grazing.

The authors suggest that rotational grazing was introduced with "heightened and unrealistic expectations that were not founded on evidence-based recommendations." Further, they point to historical contexts...that excessive stocking rates in the 19th and early 20th Century caused overgrazing that damaged rangelands. The high stocking rates common in that period were unsustainable. Expectations of grazing systems were heightened by the critical need to promote sustainable use and recovery of rangelands damaged during the early history.

Basically, the authors are saying that continuous grazing was blamed for what was really a stocking rate problem. There was a search for more intensive grazing systems that would allow recovery of rangeland health while keeping stocking rates high, but they were over-hyped and the results were disappointing. Stocking rate is still of primary importance and, with proper stocking rate, continuous grazing works as well as more intensive grazing systems.

Ecological Constraints Occur in All Grazed Ecosystems—

To accomplish the goals of both plant and animal production, grazing management must optimize both the residual lead area of plants (to maintain plant health and productivity) and forage utilization (to provide animal performance on an area basis). That's the fundamental dilemma in grazing management...balancing plant production with animal production.

Low stocking rates or grazing pressures promote plant production by maintaining high leaf area per unit land area. However, a relatively small portion of this production is harvested by livestock, the majority dies and decomposes without being consumed. This will effectively promote conservation goals over short-term profitability.

Higher stocking rates reduce plant production by decreasing leaf area per unit ground area, but both the percentage and absolute amount of plant production harvested by livestock increases. Extremely high stocking rates are associated with very high forage utilization, but plant production is reduced so severely that even these high rates of utilization do not provide sufficient forage and animal production declines. In addition to suppressed plant and animal production, excessive stocking rates are often unsustainable from the perspective of desired plant species composition, soil stability and hydrological function.

The ability to optimize plant production and forage harvest takes on even greater complexity because the timing and predictability of plant growth are constrained by limited and erratic precipitation. As aridity increases, and the timing and predictability of plant growth decreases, the potential benefit of redistributing grazing pressure in time and space becomes less important.

Stocking rates must be adjusted, regardless of grazing system, to maintain sufficient forage to carry livestock through periods of minimal plant growth. Low soil moisture available or temperature extremes limit the potential for positive vegetation responses, even if plants are given rest and deferment. Conditions of limited and erratic precipitation and productivity are the rule, rather than the exception, on most rangelands throughout the world. That's why the redistribution of grazing pressure conveys only a minor contribution to plant and animal production in grazed ecosystems compared to the variables of weather and stocking rate.

The authors acknowledge that, "the ecological dynamics and managerial challenges characteristic of most rangelands are very different from those associated with high and **(Continued next page)**

(Rotational Grazing Continued) consistent plant productions of the higher rainfall pasture systems in which the principles of rotational grazing were initially devised. (Intensive, short-duration grazing was first proposed by Voison in France in the late-1950's. His system was developed on seeded pastures with dairy cows in a climate similar to the upper Midwestern US...think Wisconsin, Ohio, up-state New York. Savory and others advocated it for more arid areas.) An overestimation of the presumed benefits of rest from grazing (e.g., several weeks rest between brief but often intensive grazing periods), may represent the primary misconception underlying continued advocacy for rotational grazing on rangelands. The authors conclude by stating, "We fully appreciate that longer-term rest and reduced stocking rate, especially during conditions favorable to plant growth, contribute to the sustainability and recovery of grazed ecosystems."

The authors go on to state that, "Rotational grazing as a means to increase vegetation and animal production has been subjected to as rigorous a testing regime as any hypothesis in the rangeland profession, and it has been found to convey few, if any, consistent benefits over continuous grazing… the ecological relationships of grazing systems have been reasonably well resolved...and a continuation of costly grazing experiments...will yield little additional information. Grazing research has demonstrated that a set of potentially effective grazing strategies exist, none of which have unique properties that set one apart from the other in terms of ecological effectiveness. This very likely occurs because performance of all ecological variables, indicating that the differences among them are dependent on the effectiveness of management, rather than unique ecological phenomena.

Experimental evidence indicates that rotational grazing is a viable strategy on rangelands, but the perception that it is superior to continuous grazing is not supported by the vast majority of experimental investigations. There is no consistent or overwhelming evidence that rotational grazing simulates ecological processes to enhance plant and animal production compared to that of continuous grazing on rangelands…."

Source

Briske, D.D., J.D. Derner, J.R. Brown, S.D. Fuhlendorf, W.R. Teague, K.M. Havstad, R.L. Gillen, A.J. Ash and W.D. Willms. 2008. Rotational grazing on rangelands: reconciliation of perception and experimental evidence. Rangeland Ecology and Management (formerly Journal of Range Management). 61 (1):` ppgs. 3-13.