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Rotational Grazing Adoption by Cow-Calf Operations

Christine Whitt and Steven Wallander





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Rotational Grazing Adoption by Cow-Calf Operations

Christine Whitt and Steven Wallander

Abstract

Rotational grazing is a management practice in which livestock are cycled through multiple fenced grazing areas (paddocks) in order to manage forage production, forage quality, animal health, and environmental quality. USDA, Natural Resources Conservation Service (NRCS) and other organizations promote rotational grazing as an important grazing practice for providing improved environmental outcomes, relative to continuous grazing, in which livestock are not cycled between grazing areas. USDA, NRCS provides financial assistance for rotational grazing and related management practices through the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and technical assistances through the Conservation Technical Assistance (CTA) program. Despite the breadth of support for rotational grazing, only limited information is available on the prevalence of rotational grazing and the variation in how producers implement the practice, including details on how frequently or “intensively” grazing operations rotate livestock between paddocks and how outcomes such as stocking density and cost relate to system characteristics. This study uses data from the 2018 Agricultural Resource Management Survey Cattle and Calves Cost and Returns Report to fill this information gap. The study finds that about 40 percent of cow-calf operations use rotational grazing, but adoption rates vary by production regions. Most rotational grazing systems are relatively simple. Only 40 percent of cow-calf operations that report using rotational grazing operations use an intensive rotational grazing schedule.

Keywords: rotational grazing, beef cattle, conservation, prescribed grazing, Environmental Quality Incentives Program, EQIP, Conservation Stewardship Program, CSP, stocking density, Agricultural Resource Management Survey, intensive grazing system, basic grazing system, regional variation

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About the Authors:

Christine Whitt is an agricultural economist in the farm economy branch and Steven Wallander is a research agricultural economist in the conservation and environment branch with the USDA, Economic Research Service.

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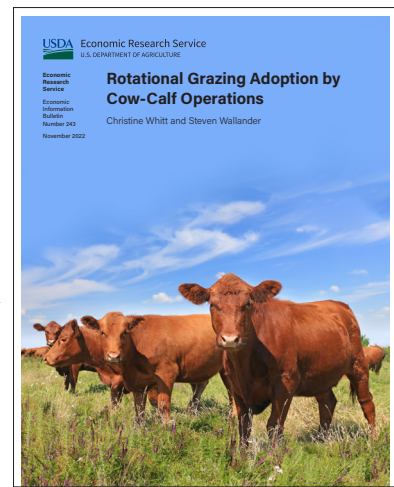
Rotational Grazing Adoption by Cow-Calf Operations

Christine Whitt and Steven Wallander

What Is the Issue?

Rotational grazing (in which grazing animals are cycled through multiple fenced grazing areas or paddocks) is frequently discussed as a livestock management practice with the potential to provide a range of public benefits or private gains. Private gains include improved animal health, forage productivity, and more drought resilient grazing livestock systems. Public benefits include improved soil health and increased soil carbon sequestration. The prescribed grazing conservation practice incentivized by USDA's Environmental Quality Incentives Program (EQIP) commonly involves rotational grazing. However, little information has been available about the extent of rotational grazing adoption, the characteristics of operations using the practice, and variations in how the practice is implemented. This report examines detailed information on the use of rotational grazing by U.S. cow-calf operations, an important subset of all cattle operations.

Details on how operations implement the practice, particularly variations in rotational grazing management, can provide a basis for tracking changes in one key aspect of grazing lands management.



What Did the Study Find?

Cow-calf operations vary in overall adoption of rotational grazing and conservation program participation.

- While 40 percent of cow-calf operations report using rotational grazing, only 40 percent of rotational grazing operations use intensive rotational grazing.
- Retained stockers, operations that retain the majority of their calves through the initial feeder stage for later sale to feedlots, are the most likely to adopt intensive rotational grazing.
- Intensive rotational grazing operations have a significantly higher average stocking density (beef cattle per total operation grazing acres) than basic rotational grazing operations. Basic rotational grazing operations tend to have larger herds and more grazing land on average than either intensive rotational grazing operations or continuous grazing operations.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

- Rotational grazing operations are more likely than continuous grazing operations to participate in Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP).

Rotational grazing adoption, seasonal use, and stocking density vary by region. Rotational grazing is more common in Northern Plains/Western Corn Belt and Appalachian regions (about one-half of operations).

- The Appalachian region, with the smallest average grazing land acreage per operation, is the only area in which intensive rotational grazing is more common than basic rotational grazing.
- In the Delta States and Southeast region, a greater share of rotational grazing operations practice year-round rotational grazing.
- In each region, the stocking density (beef cattle per total operation grazing acres) for intensive rotational grazing operations is higher than that for basic rotational grazing operations. The Delta States and Southeast region had the most densely stocked grazing land.

Rotational grazing systems differ in complexity and intensity. Most basic rotational grazing systems are relatively simple, with five or fewer paddocks, an average paddock size of 40 acres or more and use permanent fencing.

- Intensive rotational grazing systems tend to have more paddocks and smaller average paddock size than basic rotational grazing systems.

Many factors influence the average hours a week spent moving cattle.

- About 46 percent of intensive rotational grazing operations only spend 1 hour a week (on average) moving their cattle, compared to about 36 percent of basic rotational grazing operations.
- Rotational grazing operations using four or more rotations per paddock per year are more likely to spend 3 or more hours a week moving cattle, compared with rotational grazing operations using fewer rotations.

How Was the Study Conducted?

This study is based on farm-level data from a 2018 survey of U.S. beef cow-calf producers included as part of USDA's annual Agricultural Resource Management Survey (ARMS), which is jointly administered every 10 years by USDA, Economic Research Service (ERS) and USDA, National Agricultural Statistics Service (NASS). The population for the survey consists of cattle operations, with cows, heifers, and calves in the 23 largest cattle-producing States. Since the survey targets cow-calf operations, the sample list frame used by USDA, NASS typically excludes animal feeding/finishing operations that do not breed cows/heifers. Farm-level data from the survey (with operations that have at least 20 cattle) are used to characterize rotational grazing adoption rates by operation type (calving, calving/retained stocker, and calving/finisher). The survey asked respondents who used rotational grazing in 2018 to report on key characteristics of their grazing systems.

Rotational Grazing Adoption by Cow-Calf Operations

Introduction

Farmers, policymakers, conservationists, extension agents, and many grazing-related non-profit groups are focusing increasing attention on rotational grazing. Rotational grazing has the potential to improve soil health, forage productivity, and even drought resilience of pasture-based livestock systems (Undersander et al., 2002; Smith et al., 2011; Thomas, 2019). Prescribed grazing, which may include rotational grazing, has long been a focus of livestock-related financial assistance through USDA working lands programs, with most of this support coming from the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP). Reflecting this growing interest, the 2007 U.S. Census of Agriculture began asking if farming operations were practicing “rotational or management intensive grazing.” Between 2007 and 2017, the total number of cattle operations using such practices decreased from 388,912 in 2007 (40 percent of all cattle operations) to 288,719 in 2012 (32 percent of all cattle operations) to 265,162 in 2017 (30 percent of all cattle operations). Beyond this top line number, however, little information is available about how cattle operations implement and manage rotational grazing systems. To address this information gap, USDA, Economic Research Service (ERS) and USDA, National Agricultural Statistics Service (NASS) added questions about rotational grazing practices to the cow-calf version of the USDA, Agricultural Resource Management Survey (ARMS) in 2018.

Why Rotational Grazing Is Important

Many articles in the farm press and extension publications promote rotational grazing as leading to higher productivity, higher profits, and better environmental outcomes (Undersander et al., 2002; Smith et al., 2011; and Thomas, 2019). However, these articles are often based on testimony from practitioners, are regionally specific, and make conclusions that are not well supported in the experimental research on grazing systems (Briske et al., 2008). The difference in perceptions between adopters of rotational grazing and non-adopters reflects the divergence between the extension and non-profit group literature (which often draws on case-studies) and the bulk of the experimental literature. Studies based on field experiments provide support to some claims about environmental outcomes (Briske et al., 2011). Byrnes et al. (2018) conducted a meta-analysis of experiments looking at the link between grazing and soil health and found that rotational grazing, when compared to continuous grazing, is expected to increase soil organic carbon. Jensen et al. (2015) used a survey of farmers’ and ranchers’ willingness to adopt rotational grazing in response to program payments to demonstrate that an investment of \$520 million per year for rotational grazing could sequester 9.7 million metric tons of carbon, at an average cost of \$54 per metric ton of carbon.

Studies examining the on-farm economic benefits of rotational grazing are less conclusive. Meta-analyses showed that most experimental studies found no significant difference in vegetative productivity or animal productivity (Byrnes et al., 2018). Studies (Briske et al., 2008; Teague et al., 2013) have concluded that the stocking rate is more critical than the grazing system on semi-arid rangelands, and intensive rotational grazing (IRG) proved more effective in promoting benefits in humid pasturelands. Simulation studies showed mixed results in predicting either lower profit (Gillespie et al., 2008) or higher profit (Wang et al., 2018) from rotational grazing. Foltz and Lang (2005), in an observational study based on a survey of dairy operations, found no significant increase in productivity or profit under a rotational grazing system. Another potential

avenue for rotational grazing to influence farm profit is through consumers' willingness to pay more for beef produced via practices such as rotational grazing (Li et al., 2016).

Regionally, a study from the Central and Northern Great Plains found that adopters of rotational grazing were much more likely than non-adopters to perceive benefits of rotational grazing related to forage health, environmental benefits, drought resilience, and livestock productivity (Wang, 2020). Becker et al. (2017) found that ranchers generally expect increased land health under rotational grazing systems but do not tend to expect an increase in profitability. For pasturelands east of the 100th meridian, Jensen et al. (2015) found operators who were more likely to adopt rotational grazing include those with higher education, are younger and less risk averse about technology adoption, have more favorable attitudes about government incentives, and view themselves as environmental stewards. Likewise, Gillespie et al. (2007) found operations were less likely to adopt rotational grazing if the operation had certain characteristics (e.g., too few animals) and if operators were concerned about higher labor costs, or if operators were more risk averse. To resolve operators' conflicting perceptions on potentially environmentally beneficial management practices (such as rotational grazing), Gosnell et al. (2020) suggested researchers engage and build partnerships with ranchers to spur innovation and adopt potentially environmentally beneficial management practices that support rotational grazing.

Grazing systems can potentially influence environmental benefits through many different pathways, which presents a major challenge for efforts to compare rotational grazing to continuous grazing. Vegetative outcomes (such as pasture productivity and species composition) can change in response to different grazing behavior and concentration of grazing pressure within time and space (Anderson, 1988; Chestnut et al., 1992; Barnes et al., 2008). Changes in forage productivity and species composition can, if such changes are large enough, lead farmers and ranchers to adjust their stocking rates (Fales et al., 1995; Heitschmidt et al., 1990). Some case-studies suggested that rotational grazing systems (paired with higher stocking density) improved forage productivity. Adoption of rotational grazing may provide an environmental benefit because it might allow grasses to mature, which allows for deeper root growth, therefore decreasing soil erosion and improving soil health. These potential improvements might also lower weed pressure and provide opportunities for utilization of stockpiled forage (Simmons, 2019). Changes in expected stocking rates are critical for simulations that potentially may predict increased on-farm profits (Wang et al., 2018).

As with many farming practices that generate environmental benefits but are not always profitable for all farms, rotational grazing is a major focus of working lands conservation programs. Non-adopters of rotational grazing are often willing to adopt a rotational grazing system under contracts that provide a minimum necessary financial incentive (Kim et al., 2008; Wang, 2020). Through the "prescribed grazing" practice, USDA, NRCS provides financial assistance to improve pasture and rangeland management, which often involves rotational grazing in combination with other management activities. Prescribed grazing generally includes rotational grazing (Foltz and Lang, 2005). From 2005 to 2018, USDA, NRCS provided more than \$278 million (2018 dollars) in financial assistance for the prescribed grazing practice and additional funding for closely related practices, such as livestock fencing under EQIP. The Conservation Stewardship Program (CSP) also provides additional financial support and technical assistance for prescribed grazing and associated management activities.

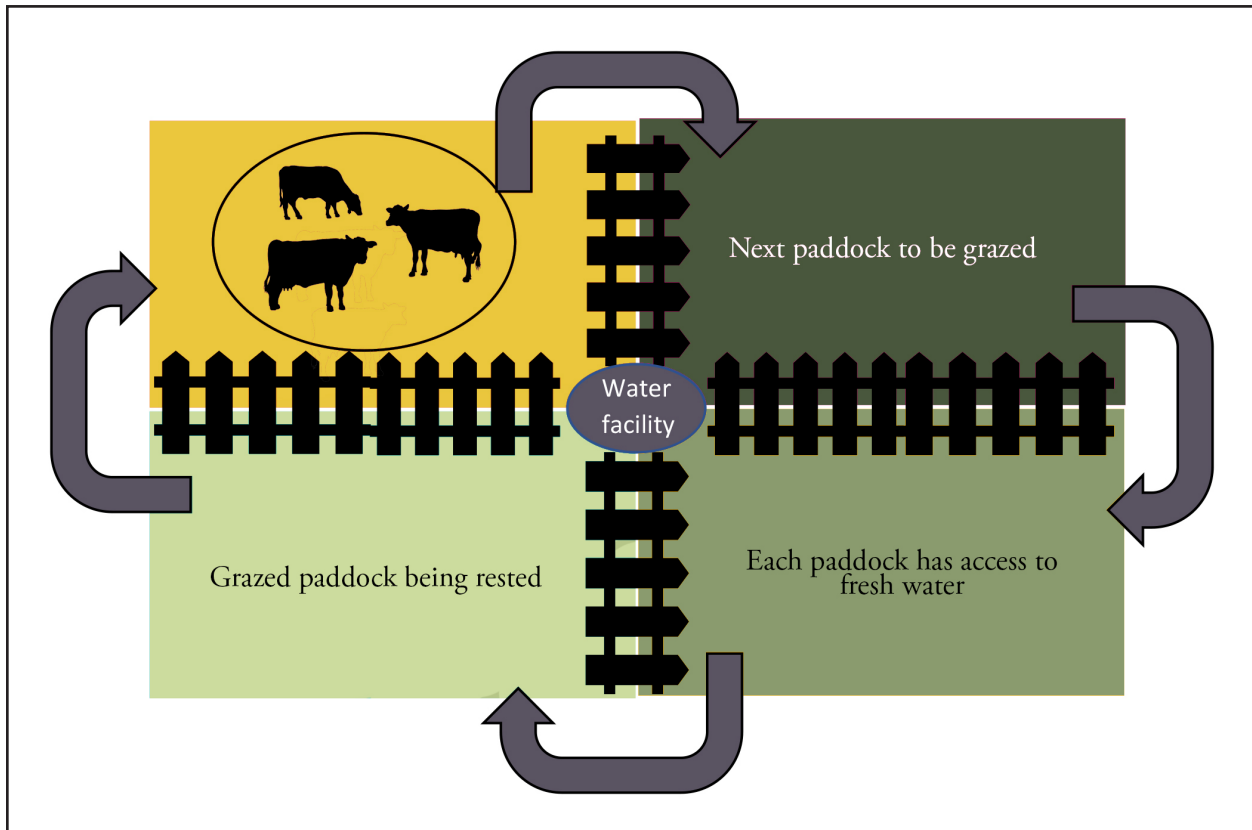
Defining Rotational Grazing

The most basic definition of rotational grazing is the intentional movement of livestock between at least two enclosed areas of pasture or range (commonly referred to as paddocks) with recurring periods of grazing and rest (Heidschmidt and Taylor, 1991; Briske et al., 2008; Smith et al., 2011; Becker et al., 2017). Some researchers set a higher threshold on the minimum number of paddocks as the dividing line between contin-

uous and rotational grazing (Kim et al., 2008; Smith et al., 2011; Jensen et al., 2015; Wang et. al., 2020). Jensen et al. (2015) also included a maximum grazing period duration of 14 days. In this report, the authors relied on survey respondents self-identifying as having engaged in rotational grazing, based on a definition that reflects the two-paddock threshold.

Rotational grazing can be practiced with varying levels of intensity. Producers can adjust the duration of grazing periods on a single paddock and the frequency and timing of movements between paddocks. In a simple four-paddock grazing system, livestock would typically graze one paddock while the other three paddocks rest (figure 1). Although this example depicts 1 week as the shortest grazing period, some farmers rotate animals more frequently. Resting periods allow the forage plants to recover between grazing periods (Undersander et al., 2002). Given a set number of paddocks, a rotational grazing system can vary significantly in the length of the grazing period (the number of days that livestock graze a single paddock). Changes in the grazing period then translate into different lengths of rest and numbers of rotations over the grazing season (figure 2).

Figure 1
Rotational grazing schematic



Notes: In this stylized chart, a single herd is rotated through four paddocks. Fence and a shared watering facility provide the infrastructure necessary to implement this system. After a single grazing period, the herd is rotated to the paddock that has completed a full resting period while the other paddocks continue to recover from prior grazing.

Source: USDA, Economic Research Service.

Figure 2

Sample grazing schedules by number of paddocks and rotation length

Paddock	Month															
	May				June				July				August			
	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Single pasture, no rotation																
1	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
Four paddocks, 4-week grazing, 12-week rest																
1	█	█	█	█												
2					█	█	█	█								
3									█	█	█	█				
4													█	█	█	█
Four paddocks, 2-week grazing, 6-week rest																
1	█	█							█	█						
2			█	█							█	█				
3					█	█							█	█		
4							█	█							█	█
Four paddocks, 1-week grazing, 3-week rest																
1	█				█				█				█			
2		█				█				█				█		
3			█				█				█				█	
4				█				█				█				█
Eight paddocks, 1-week grazing, 7-week rest																
1	█								█							
2		█								█						
3			█								█					
4				█								█				
5					█								█			
6						█								█		
7							█								█	
8								█								█
Legend	█	= grazing period for given paddock														

Notes: In this stylized schedule, grazing periods and resting periods are assumed to be fixed and equal across all paddocks over a 4-month grazing season. Reducing the length of the grazing period leads to a reduction in the length of the rest period and an increase in the number of full rotations through all paddocks. Increasing the number of paddocks allows for longer resting periods.

Source: USDA, Economic Research Service.

The grazing systems illustrated in figure 2 are ordered from least intensive to most intensive. A less-intensive system uses longer grazing periods. If the number of paddocks is fixed, this translates into longer resting periods. A more intensive system uses shorter grazing periods, which also translates into shorter resting periods and more rotations over time, assuming the number of paddocks remains fixed and was not appropriately designed in the first place. A more intensive grazing system can also involve dividing the pasture or range into more, smaller paddocks, which increases intensity. Intensity is measured as the number of livestock per acre at a given point in time. Figure 2 shows grazing periods of equal length (days or weeks) to keep the tradeoffs between number of paddocks, grazing period, and resting periods. In many applications, grazing

periods and rotations are likely to vary as the speed of plant recovery and growth changes throughout the year.

Because system characteristics are highly intertwined, the rotational grazing literature cites a variety of methods to distinguish between basic rotational grazing (BRG) and intensive rotational grazing (IRG).¹ Grazing systems can be differentiated based on the number of paddocks (Becker et al., 2017), rotation frequency (Ostrom et al., 2000; Foltz and Lang, 2005), or the length of the grazing period (Derner et al., 2008; Wang et al., 2020; 2021). Some early studies of rotational grazing relied on vegetative condition such as forage height to differentiate systems (Andersen, 1988; Chestnut et al., 1992). This report defines IRG as systems that use an average grazing period of 14 or fewer days per paddock, the same definition used in Wang et al. (2020).

Data Used in the Report: ARMS Cow-Calf Survey

The data on rotational grazing come from the 2018 Agricultural Resource Management Survey Cattle and Calves Cost and Returns Report (2018 Beef Cow-Calf ARMS). This data captures an important subset of cattle operations in the U.S. Census of Agriculture. The Census of Agriculture captures the entire population of cattle producers (including cow-calf, backgrounders, and feedlot operations). The 2018 Beef Cow-Calf ARMS is a subset of the total cattle population captured in the Census of Agriculture and only surveys cow-calf operations. A further restriction imposed by the data was that the smallest operations were excluded, as only operations with at least 20 cows, including cows and heifers that calved (each cow-calf pair as 1 cow), were surveyed. The 2018 Beef Cow-Calf ARMS also collects data from the 23 States that are the largest producers (figure 6). The ARMS data are statistically representative of cow-calf producers for a selection of States that represent 86 percent of U.S. beef cattle and 75 percent of calves (based on January 2018 cattle population numbers).

The survey asked respondents to identify the number of paddocks, the average acres per paddock, and the average number of days the herd grazed a paddock in the rotational grazing system. This response allows examination of the intensity of rotational grazing on operations. Respondents were also asked to select which months beef cattle are in the rotational grazing system. This response allows determination of how seasonal patterns and land use varied across operations, allowing a comparison against cow-calf operations that did not use the practice.

USDA, Natural Resources Conservation Service Programs

USDA's Environmental Quality Incentives Program (EQIP) provides financial assistance to farmers and ranchers who adopt conservation practices on their working lands. Since 1996, EQIP has provided payments that cover a portion of the costs of installing or adapting a practice that meets USDA, NRCS technical specifications. Since 2012, USDA, NRCS has used rates that are regionally adjusted to reflect regional economic conditions. The practice scenarios used to calculate payment rates may be developed at the national level or regional level with national level approval. Congressional authorization of EQIP limits the reimbursement to be no more than 75 percent of design and installation costs for most participants, and not more than 90

¹ There is also variation in the terminology used to describe grazing intensity. Some studies use the terms "management intensive grazing (MIG)" (Wang et al., 2021) or "management intensive rotational grazing (MIRG)" (Ostrom et al., 2000; Foltz and Lang, 2005). Intensity measures are not included in this report because they usually involve measures of the rotation schedule and do not involve measures of management effort, such as time or capital.

percent of those costs for participants who are beginning, veteran, limited resource, or socially disadvantaged. For all types of producers, the payment schedule can include reimbursement for up to 100 percent of direct costs and/or foregone income.² Most of the practices eligible for EQIP funding provide a mix of on-farm benefits to farmers and ranchers and broader public benefits.

USDA, NRCS defines prescribed grazing as “managing the harvest of vegetation with grazing and/or browsing animals with the intent to achieve specific ecological, economic, and management objectives” (USDA, NRCS, 2017). Grazing or browsing generally include livestock with diets that consist primarily of plants, either directly through foraging or through supplemental feed of forage or grains. In some cases, a prescribed grazing practice may also account for wildlife that feed through grazing or browsing. Prescribed grazing can include practices focused on controlling livestock access to waterways, minimizing livestock concentration areas, improving or maintaining ground cover, or providing rest or deferment from grazing to prevent stress or damage to key forage plants (USDA, NRCS, 2017).

The EQIP practice (practice code 528) called “prescribed grazing” involves adopting an operation-specific plan to “manage stocking rates and grazing periods to adjust the intensity, frequency, timing, duration, and distribution of grazing” (USDA, NRCS, 2017). That grazing plan must achieve a balance between forage production (in combination with any supplemental feed) and expected feed demand from livestock. In addition, that plan must include a grazing plan or schedule, a contingency plan for situations where forage production suffers shocks, such as during a drought, and a monitoring plan. Some degree of rotational grazing is an aspect of the conservation practice standard that covers all prescribed grazing practices funded through EQIP. From 2005 to 2018, EQIP contracts obligated \$278 million (2018 dollars) nationally in funding toward the prescribed grazing practice. To implement the prescribed grazing practice, participants must also manage their grazing systems to meet criteria related to forage quality, for animal health, forage-animal balance, livestock water availability, and contingency planning for unexpected disturbances to forage production (such as drought or wildfire). Since these criteria often involve implementation of additional conservation practices, such as water developments, cross-fencing, brush management, pasture planting, EQIP contracts with prescribed grazing regularly include financial assistance beyond the prescribed grazing practice. The total obligations on EQIP contracts with prescribed grazing practice from 2005 to 2018 amounted to \$1.66 billion (2018 dollars) nationally (table 1). The 23 States represented by ARMS data in this report received 60 percent of this funding on contracts with prescribed grazing practice. While this total suggests total EQIP support for rotational grazing, a precise number of acres under a rotational grazing plan is difficult to define. Additionally, many of the supporting practices listed are necessary on contracts that didn’t include the prescribed grazing practice. Fencing is about twice as common on contracts that do not have prescribed grazing. Water facilities are about three times as common, and brush management is about five times as common. These differences could occur because these practices can be used for other management reasons unrelated to prescribed grazing or some operations already implement prescribed grazing but USDA, NRCS conservationists recommend their adoption to hasten treatment of natural resource concerns, resulting in the development of contracts that do not include the prescribed grazing practice.

² See 16 U.S. Code § 3839aa–2 for upper limits on payment rates. See Part 613 NRCS Nature Economics Handbook for cost calculation methodology.

Table 1

EQIP funding for prescribed grazing and related practices from 2005 to 2018

Practice (NRCS practice code)	Contracts with prescribed grazing		Livestock contracts without prescribed grazing	
	Total obligations (millions of 2018 dollars)	Practice count	Total obligations (millions of 2018 dollars)	Practice count
Prescribed grazing (528)	278	98,038	N/A	N/A
Top practices in terms of funding (rank order based on prescribed grazing funding amounts)				
Fence (382)	357	71,956	618	147,802
Livestock pipeline (516)	154	40,644	375	95,396
Brush management (314)	118	19,249	647	105,094
Forage and hay planting (512)	105	26,875	306	81,418
Watering facility (614)	103	47,804	246	118,708
Heavy use area protection (561)	73	23,715	361	68,213
Water well (642)	53	7,997	178	28,744
Range planting (550)	38	3,240	75	12,923
Waste storage facility (313)	37	1,291	1,083	21,203
Pumping plant (533)	34	9,615	270	44,121
Pond (378)	21	3,701	119	24,494
All other practices	285	90,653	8,975	1,631,742
Total	1,657	444,778	13,254	2,379,858

Notes: USDA, NRCS = Natural Resources Conservation Service. EQIP = Environmental Quality Incentives Program. Livestock contracts without prescribed grazing does not necessarily mean that prescribed grazing is not being implemented. Producers may already be doing it on their own or prefer to do it without USDA, NRCS financial assistance. N/A = not available.

Source: USDA, Economic Research Service analysis of end-of-fiscal-year ProTracts data for obligated (signed) EQIP contracts.

USDA's Conservation Stewardship Program (CSP) also provides financial assistance to promote conservation on working lands. Unlike EQIP, CSP primarily provides incentives for farmers and ranchers who are already using conservation practices to adopt improved versions of those practices. Within CSP, improved practices are generally referred to as "enhancements." Prior to 2017, CSP provided payments based on a complex scoring system that referred to all management practices on an individual operation, which made it difficult to calculate the total amount of support for an individual practice. Since 2017, CSP has used a payment system that is similar to EQIP. According to USDA, NRCS data on CSP payments from 2017 to 2019, more than 80 percent of the acreage enrolled in the grazing land CSP enhancement program used prescribed grazing (USDA, NRCS, 2021).

Both EQIP and CSP require farmers and ranchers to develop conservation plans before applying for the programs. These plans provide an assessment of the land's resource concerns and identify practices that address those concerns. For a practice or enhancement to receive financial assistance through EQIP or CSP, it must appear in the conservation plan. However, plans can include practices that are recommended but not required or practices the producer adopts without financial assistance from USDA, NRCS. Conservation plans are commonly in collaboration with USDA, NRCS county staff through the Conservation Technical Assistance Program. Ranchers looking to implement prescribed grazing can receive technical assistance through USDA, even without receiving financial assistance. When conservation payments lead to a change in farm practice(s) that results in improved environmental quality, and would not have occurred without the

payments, additionality is achieved. Conservation payments funding structural and vegetative practices, which require high installation costs and have limited on-farm benefits, have been found to have high additionality (Claassen et al., 2014). However, the additionality of prescribed grazing practices has not been studied.

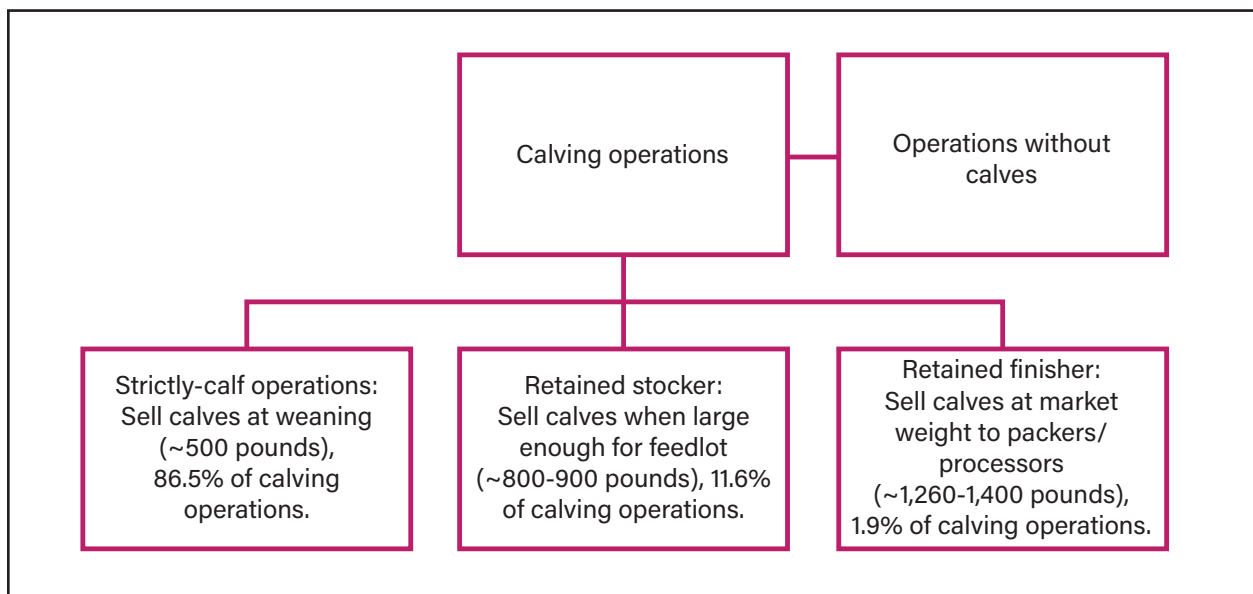
Findings

The researchers analyzed the first-ever operation level rotational grazing data from the 2018 Beef Cow-Calf ARMS. They examined the types of operations practicing rotational grazing, unique characteristics of rotational grazing operations, the regional variation of rotational grazing management, and differences between intensive rotational grazing (IRG) and basic rotational grazing (BRG) systems. They explored and offered perspective on how many characteristics of rotational grazing systems (such as the number of rotations, paddock size, and number of paddocks) are interrelated.

Who Is Practicing Rotational Grazing?

Cow-calf operations are categorized into three homogenous groups based on when calves are sold: strictly-calf, retained stocker, and retained finisher (figure 3). Strictly-calf operations sell all calves produced that year at or around weaning. Approximately 87 percent of beef cattle operations are strictly-calf operations. Retained stocker operations retain some or all their calves after weaning and continue grazing them until they are ready to send to a feedlot or finisher. The retained stocker population is almost 12 percent of cow-calf operations. The retained finisher operations raise some or all their calves to market weight and sell them to processing plants. This group is significantly smaller and represents only about 2 percent of cow-calf operations. Operations without calves are often the next stage of production and include backgrounders (purchase weaned calves and graze them until ready to sell to feedlot), feedlots, and grass-finishing operations. These operations purchase either weaned calves or stockers for finishing. Operations that do not breed cows and only purchase calves or stockers to graze may practice rotational grazing; however, 2018 Beef Cow-Calf ARMS does not capture rotational grazing data on these cattle operations.

Figure 3
Depiction of the three cow-calf production systems included in the report

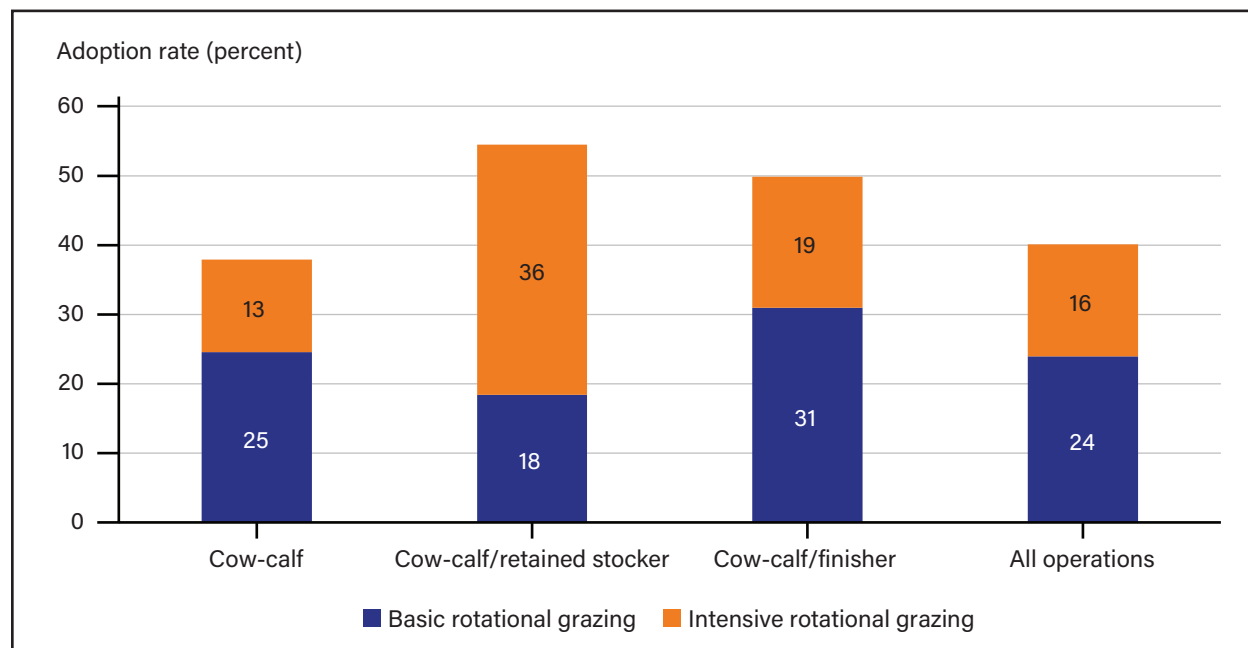


Note: The symbol ~ refers to average weight that calves are sold.

Source: USDA, Economic Research Service.

About 40 percent of cow-calf operations report using a rotational grazing system (figure 4). Based on the 14-day grazing period threshold, 16 percent of all cow-calf operations use IRG and 24 percent use BRG. Overall adoption and the breakdown between IRG and BRG differs by type of cow-calf operation. Retained stocker operations are more likely to adopt rotational grazing in general than strictly-calf operations. Retained stocker operations are also more likely to adopt IRG than either strictly-calf or retained-finisher operations.

Figure 4
Intensive and basic rotational grazing adoption rates by cattle operation type



Notes: Cow-calf operations sell all calves produced that year at or around weaning. Retained stocker operations retain some or all calves after weaning and continue grazing them until they are ready to send to a feedlot or finisher. Retained finisher operations raise some or all calves to market weight and sell them to processing plants. Continuous grazing practice is adopted in the remaining operations (100—basic rotational grazing—intensive rotational grazing).

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

IRG are systems with an average grazing period of 14 or less days per paddock. BRG systems have an average grazing period of more than 14 grazing days per paddock. Since previous studies differed in where to draw the line between IRG and BRG, table 2 shows the variation in grazing period length within the population of all cow-calf rotational grazing systems. Using a 7-day grazing period as the threshold for an IRG definition, Foltz and Lang (2005) would reclassify 22 percent of rotational grazing operations as BRG rather than IRG. Using an extremely strict threshold of 2 or fewer days per grazing period, Heitschmidt et al. (1990) and Jacobo et al. (2006) would reclassify 38 percent of rotational grazing operations as BRG rather than IRG. Other approaches (such as a definition based on the number of paddocks), as in Kim et al. (2008) or Becker et al. (2015), would also lead to significant reclassification of operations based on intensity.

Table 2

Distribution of rotational grazing operations by average number of grazing days per paddock

Rotational grazing-type	Grazing days	Percentage of rotational grazing operations
Intensive rotational grazing	1-2	2
	3-4	1
	4-7	15
	8-14	22
Basic rotational grazing	15-21	14
	22-30	23
	31 or more	23

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

The differences in average operation characteristics between continuous grazing, BRG, and IRG systems provide an overview of factors that either drive decisions about which grazing system to adopt or are an outcome of the grazing system decision (table 3). Operations using BRG have larger herds than continuous grazing operations. For this comparison, herd size includes cows, heifers (adult females that have not borne a calf), bulls, and milk cows and counts a cow-calf pair as one head. Operations with BRG and continuous grazing operate more acres on average than IRG operations. Operations utilizing BRG operate more acres of grazing land than either IRG or continuous grazing operations.

Table 3

Comparing operations with rotational grazing and operations without rotational grazing

	Continuous grazing (a)	Basic rotational grazing (b)	Intensive rotational grazing (c)
Average herd size (head)	97 ^b	129 ^a	98
Average operation acres (acres)	1,146 ^c	1,515 ^c	650 ^{ab}
Average stocking density for total grazing land acres (head/grazing land acres)	0.46	0.35 ^c	0.53 ^b
Average total hours principal operators worked off the farm in 2018	1,651 ^{bc}	1,910 ^a	1,884 ^a
Average pasture size (acres)	587 ^b	942 ^{ac}	396 ^b
Percent with crop land	63	69	69
Average cost of purchased feed per head in U.S. dollars	87	87	97
Average cost of homegrown feed per head in U.S. dollars	167	175	203
Average cost of grazing feed per head in U.S. dollars	113	118	102
Average cost of total feed per head in U.S. dollars	366	381	402
Percent participating in EQIP	0.6 ^{bc}	2.7 ^a	7.1 ^a
Percent participating in CSP	2.1 ^{bc}	5.2 ^a	7.0 ^a
Self-reported exposure to water quality regulation (percent)	5.4 ^{bc}	10.5 ^a	17.5 ^a
Self-reported exposure to manure regulation (percent)	3.7	5.5	7.4

Notes: EQIP = Environmental Quality Incentives Program. CSP = Conservation Stewardship Program. The superscripts refer to the results of a pairwise t-test statistical tests between item means in each column. All tests are expressed at a 95-percent level of confidence. A lettered superscript denotes that the item means reported in a row is significantly different from that in the superscript column. The tests were conducted using a jackknife variance estimator, with 30 replications provided with the ARMS data.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Intensity of grazing systems is closely related to stocking density or stocking rate. Stock density is a measure of the number of livestock in a given size area. Stocking rate refers to the number of livestock per unit area for a specified time (see box, “Difference Between Stocking Density, Stocking Rate, and Carrying Capacity”). Despite their importance, due to data limitations on forage availability in pastures, calculating an operation’s stocking rate is not possible in this report. Table 3 expresses stock density as the average number of cattle that are grazing total grazing land at a given time. IRG operations have the highest stock density (0.53 head-per-grazing land-acre), which is significantly larger than the BRG stock density (0.35 head-per-grazing land-acre). The stocking density for continuous grazing (0.46 head-per-grazing land-acres) is not statistically different from either BRG or IRG. Although IRG operations had higher stock densities than BRG operations, no significant difference was found between average costs of supplemental feed (purchased and home-grown feed) for IRG, BRG, and continuous grazing operations. Also, grazing feed costs per year (the opportunity costs of producing another commodity on the land) were similar across the three grazing systems.

Difference Between Stocking Density, Stocking Rate, and Carrying Capacity

The terms “stocking density” and “stocking rate” refer to the relationship between grazing animals and the land they graze. “Stocking density” is the number of animals grazing on a given plot of land at one point in time, while “stocking rate” is simply stock density for a specified length of time. Either term can characterize the amount of land per animal (animal unit). Stocking rate differs from stock density because a measure of time is included for stocking rate. Typically, stocking rate is expressed in animal unit months (AUM) per acre, and the rate maps easily to the average dry weight of forage required by a lactating 1,000-pound cow and her calf for a month (roughly 790 pounds of dry forage). Stock density can be expressed as either AU/acre, or acres/AU, while stocking rate is expressed as either AUM/acres, or acres/AUM, or even as animal unit days (AUD), which is common for more intensively managed livestock systems.

Carrying capacity expresses the amount of animals a given grazing area can support with respect to usable forage. The area often includes wildlife and domestic herbivores. Typically, the stocking rate goal within a grazing plan allocates a percentage of the carrying capacity to wildlife, so the stocking rate is less than the carrying capacity.

One of the potential costs of rotational grazing systems is the amount of operator time required to move cattle between paddocks, which can lead to a potential tradeoff between on- and off-farm work (Undersander et al., 2002). However, in these data, operators with IRG and BRG rotational grazing systems worked significantly more hours off the farm in 2018 than principal operators practicing continuous grazing.

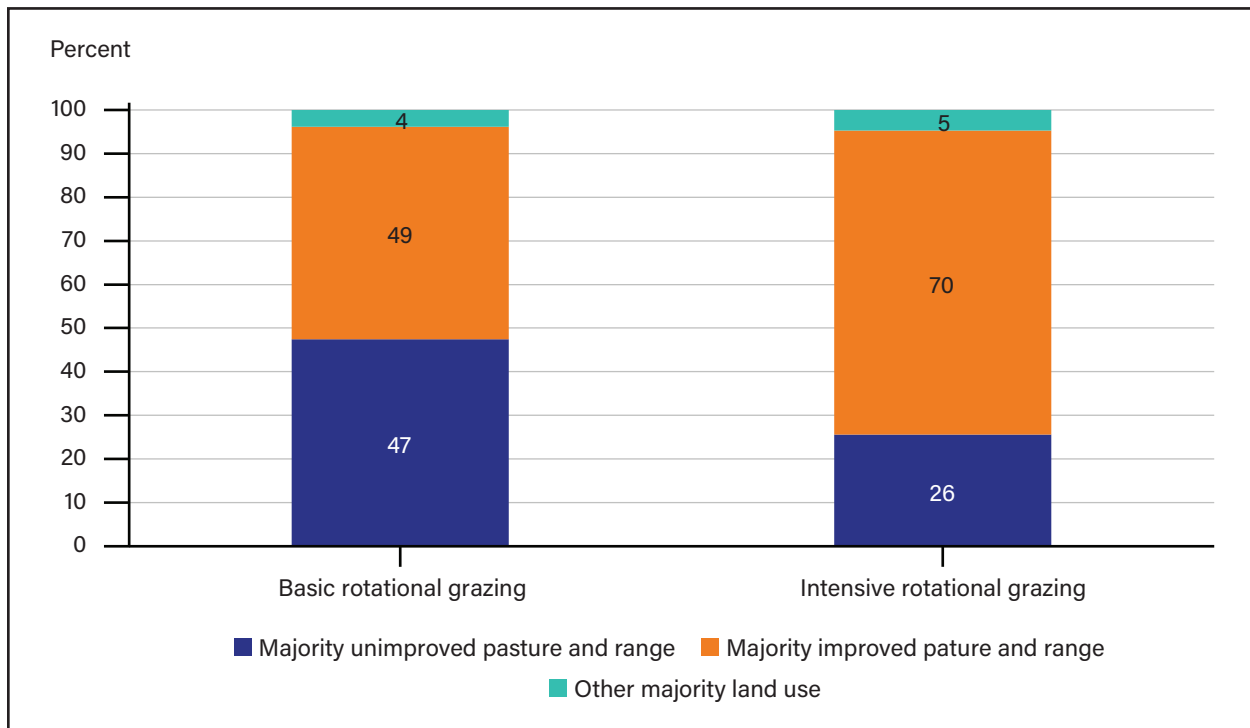
The share of operations participating in EQIP and CSP programs is significantly greater for operations practicing rotational grazing than for operations using continuous grazing. Greater use of EQIP by IRG and BRG adopters may be a consequence of the high infrastructure cost of IRG and BRG systems, especially if permanent fencing is used. No difference is evident between the share of IRG and BRG operations participating in EQIP or CSP. Rotational grazing operations are also more likely to self-report being subject to environmental water regulations. These findings could be related because of conservation program design. Under the authorizing legislation, EQIP is charged with helping farmers and ranchers comply with regulations and use of rotational grazing could be a means of complying with local or State rules related to issues such as manure management and water quality.

While the possible links between conservation programs, regulation, and rotational grazing are notable, the rate of participation in EQIP or CSP is relatively low for all surveyed operations. However, past participation in EQIP or CSP may have influenced current rotational grazing adoption rates and systems. A larger share of operations report exposure to regulation than participation in either EQIP or CSP. According to respondents, a larger percentage of rotational grazing operations self-report that they are exposed to either water quality or manure regulations compared to those reporting that they use traditional grazing operations.

Pasture Improvement and Regional Differences in Rotational Grazing

Rotational grazing is one way (when managed correctly) to improve livestock health, water quality, and forage quality (Briske et al., 2011). The operator may also potentially improve the land via seeding, fertilizing, or installing irrigation systems. While many improvements are useful for distinguishing between rangeland (mostly unimproved) and pasture (some improvement), this study looks at unimproved versus improved pasture and rangeland combined. The reason for this is that the ARMS survey, like a number of other surveys, asks respondents to self-report the amount of range and pastureland combined that is either unimproved or improved. Compared to rotational grazing alone, operations investing in improving their land through seeding and fertilizing increase forage productivity at a faster rate (Undersander et al., 2002). For this analysis, the authors break down BRG and IRG into three land management types. The first category is “unimproved” and includes operations where 50 percent or more land is either unimproved rangeland, permanent pasture, or native pasture. The “improved” category refers to operations with 50 percent or more rangeland, permanent pasture, or native pasture that has been improved (e.g., seeded, applied fertilizer, or irrigated). The remaining category captures operations of all other types of grazing land (including forest, cropland, and other). Almost 70 percent of IRG operations use improved land, whereas about 49 percent of BRG operations are on improved land. BRG operations are more likely to use unimproved land, compared to a quarter of IRG operations (figure 5).

Figure 5
Grazing land improvement and rotational grazing intensity

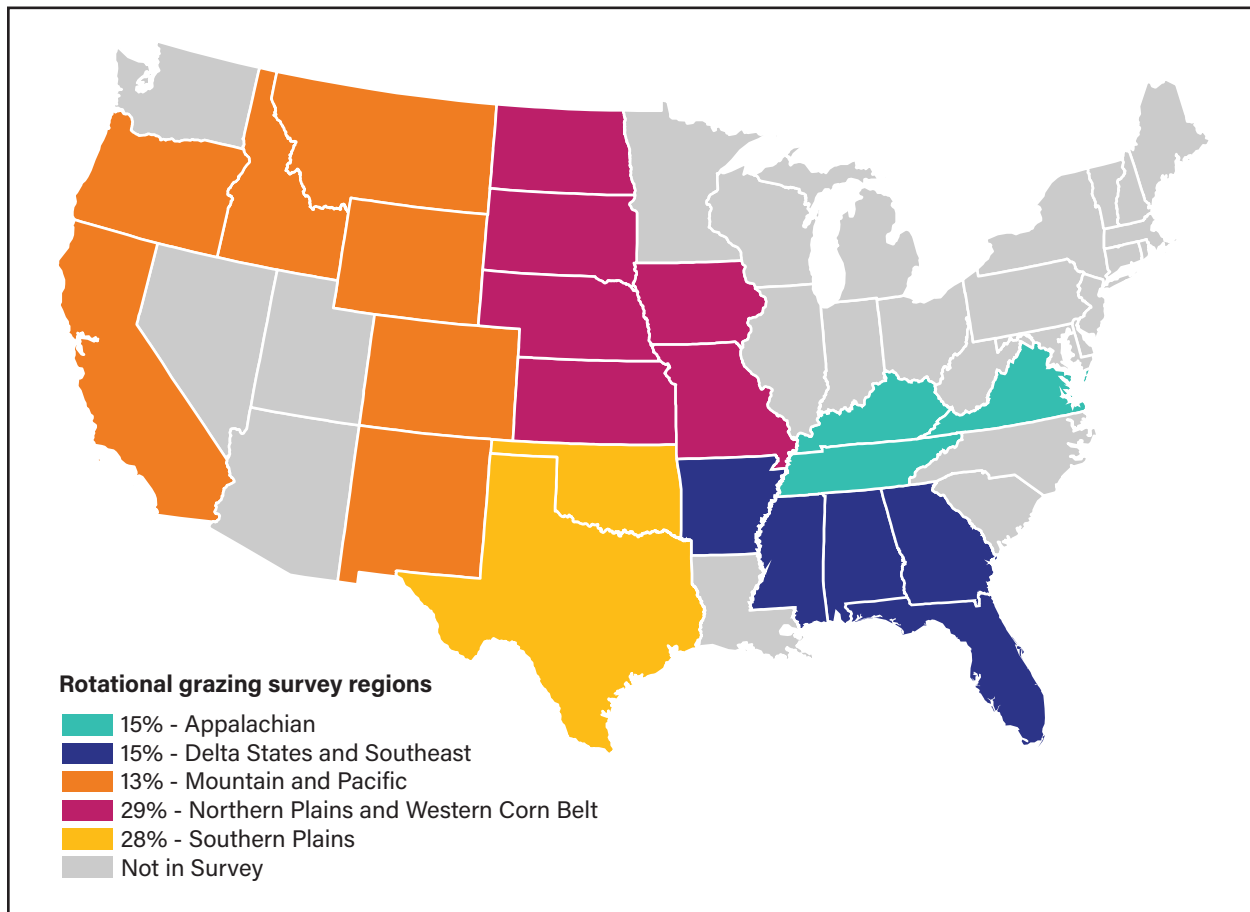


Notes: Respondents self-report the amount of range and pastureland combined that is either unimproved or improved. Improvement can include use of fertilizer, seeding, irrigation, or other methods of increasing forage production or quality. Due to rounding, not all percentages add to 100.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Different regions of the United States may be more conducive to rotational grazing than others. Regional variation in rainfall, soil quality, native forage, or forage quality could lead to different adoption rates of rotational grazing and could affect seasonal adoption as well. For this research, the 23 survey States are divided into 5 regions based on geographic differences in climate and forage growing conditions, as well as ERS analysis of the number of survey responses in each State. Some regions contain fewer States because those States have larger ARMS sample sizes that reflect their higher concentrations of cattle and calf operations. The five regions used in this study are: Appalachian (Kentucky, Tennessee, and Virginia); Mountain/Pacific (California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming); Northern Plains/Western Corn Belt (Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota); Delta States/Southeast (Alabama, Arkansas, Florida, Georgia, and Mississippi); and Southern Plains (Oklahoma and Texas). Figure 6 depicts the distribution of surveyed cow-calf operations by region. A key point to remember when discussing the rotational grazing adoption rates is each region has varying forage types, which may respond better to rotational grazing than others.

Figure 6
Distribution of surveyed cow-calf operations by region

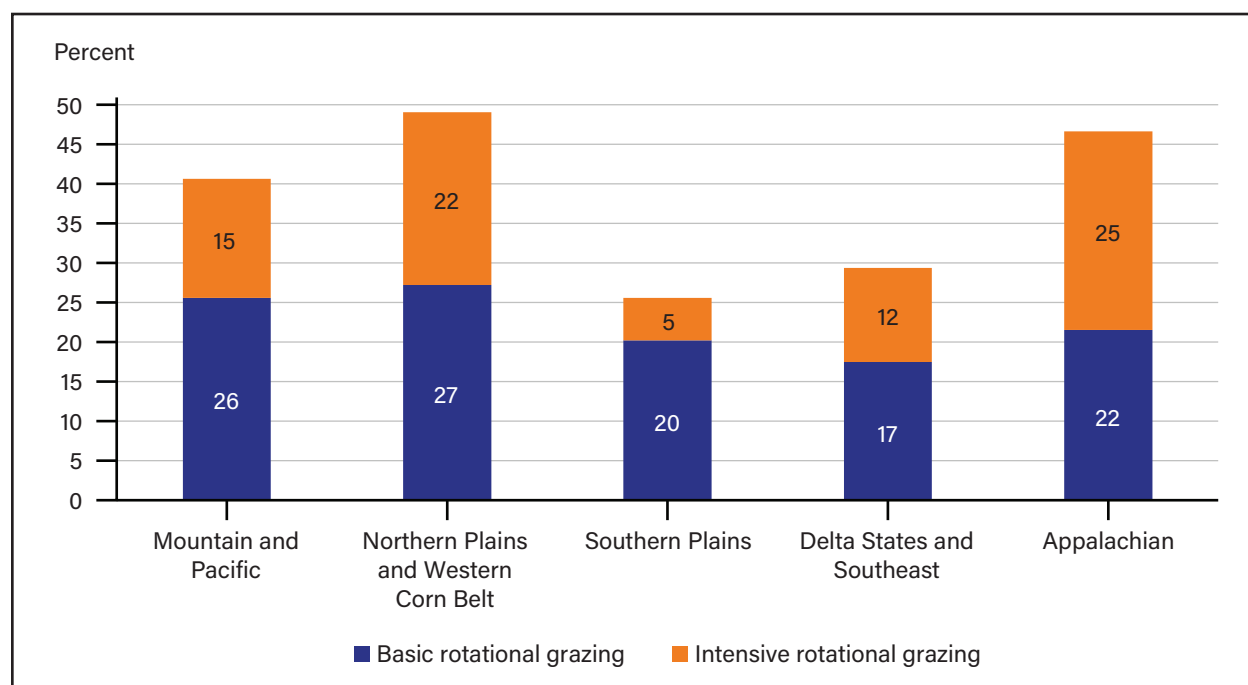


Notes: States included in the 2018 Cow-Calf ARMS were selected so that the survey represents over 80 percent of total production by beef cattle and calve operations. The five regions were selected for this study to capture major differences in pasture and range productivity and were grouped to take into account sample sizes in each State. Percentages report the total weighted share of cow-calf production by region within the sample.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

The Northern Plains and Western Corn Belt region has the highest adoption rate for rotational grazing systems, with 49 percent of beef cattle operations practicing it (figure 7). Rotational grazing becomes less common toward the southern and eastern United States. The BRG adoption rate is fairly consistent across all regions. However, the rate of IRG adoption varies more widely and is the source of regional variability in rotational grazing. Southern Plains operations have the lowest rotational grazing adoption rate at about 25 percent, and smallest share of IRG adopters. Appalachian and Mountain and Pacific regions share similar adoption rates of 47 and 41 percent. Although the Northern Plains and Western Corn Belt region has the largest adoption rate, the Appalachian regions has the highest percentage of IRG adoptions.

Figure 7
Adoption rate of farms practicing rotational grazing by region



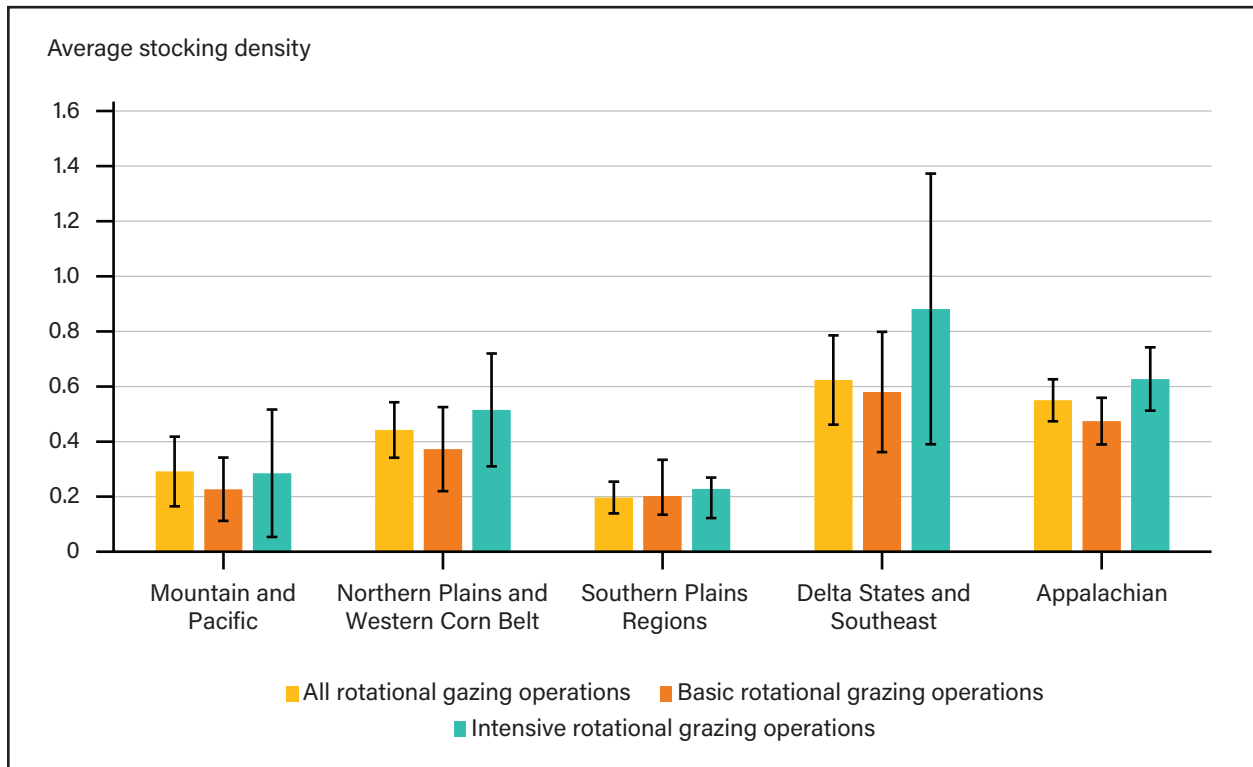
Notes: The Mountain and Pacific region consists of California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming. The Northern Plains and Western Corn Belt region consists of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. The Southern Plains region consists of Oklahoma and Texas. The Delta States and Southeast region consists of Alabama, Arkansas, Florida, Georgia, and Mississippi. The Appalachian region consists of Kentucky, Tennessee, and Virginia. The remaining value (100—basic rotational grazing—intensive rotational grazing) in the bar graph is percentage of continuous grazing operations.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Figure 8 shows that the average stocking density (beef cattle per total operation grazing acres) varies by region. In each region, the stocking density for IRG operations is higher than that for BRG operations. Rotational grazing operations in the Delta States and Southeast region have the most densely stocked grazing land, with an average of 0.6 head per grazing land acre. Also, IRG operations in the Delta States and Southeast region have the highest average stocking density at 0.9 head per grazing land acre. IRG and BRG operations in the Southern Plains region have the smallest at 0.2 head per grazing land acre. The Southern Plains region is the most arid of the five regions due to a combination of high temperatures and relatively low annual rainfall. Therefore, the forage quality or growth could limit the number of beef cattle in each paddock (Ball et al., 2001). However, figure 9 shows the BRG operations had similar purchased and home-grown feed costs, but information on why and when the supplemental feed was fed is unknown. Additionally, IRG and BRG operations in the Southern Plains regions had the lowest total feed costs on average at \$234 and \$316 per head, respectively, compared to the other regions. All BRG operations were found to have slightly higher total feed costs per head compared to IRG in each region, except in the Northern Plains and Western Corn Belt. IRG operations in these regions had much higher total feed costs per head compared to their BRG counterparts.

Figure 8

Average stocking density per grazeland acres for operations, with rotational grazing by region

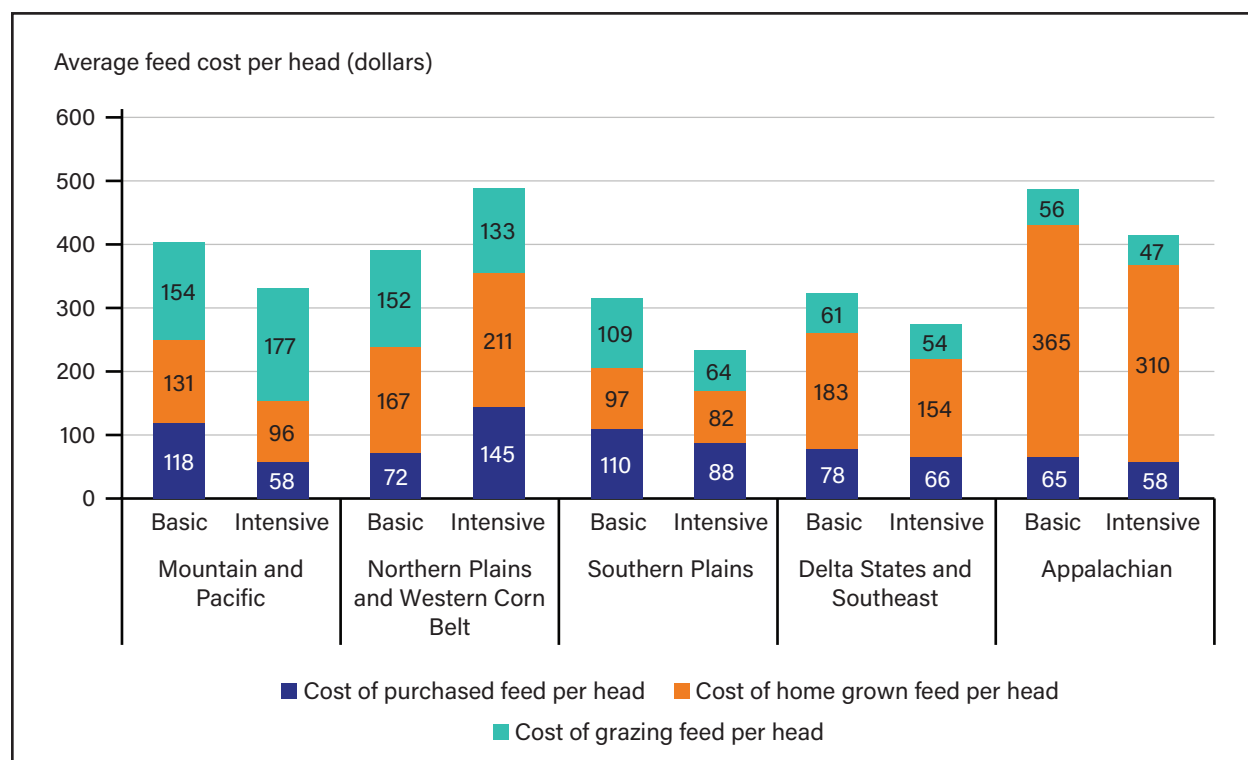


Notes: Stocking density is the number of animals grazing on a given plot of land at one point in time. The lines on the figure are confidence intervals estimated at 95 percent using the jackknife replicate standard errors. The Mountain and Pacific region consists of California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming. The Northern Plains and Western Corn Belt region consists of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. The Southern Plains region consists of Oklahoma and Texas. The Delta States and Southeast region consists of Alabama, Arkansas, Florida, Georgia, and Mississippi. The Appalachian region consists of Kentucky, Tennessee, and Virginia.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Figure 9

Average feed cost per head by region for rotational grazing operations



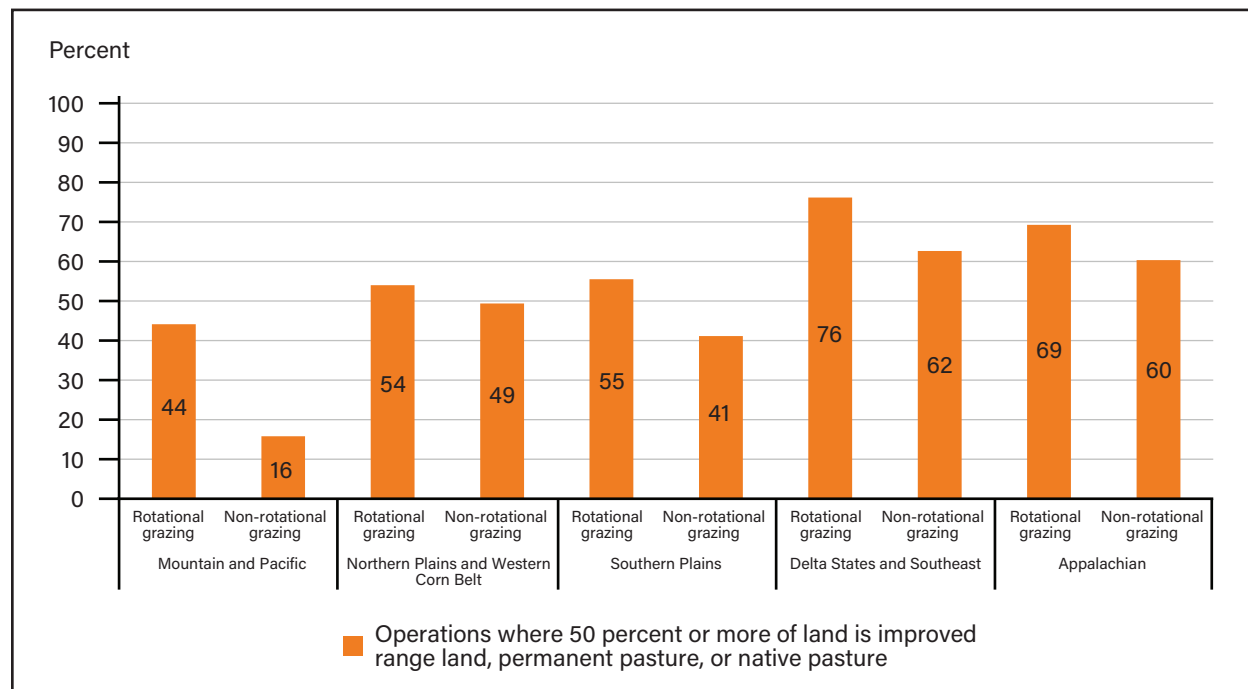
Notes: The Appalachian region consists of Kentucky, Tennessee, and Virginia. Mountain and Pacific region consists of California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming. The Northern Plains and Western Corn Belt region consists of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. The Delta States and Southeast region consists of Alabama, Arkansas, Florida, Georgia, and Mississippi. The Southern Plains region consists of Oklahoma and Texas. Costs for homegrown feed and grazing feed are based on opportunity cost as reflected in the methodology used to produce the USDA, ERS cost of production estimates.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Many factors can be attributed to the variation of stocking density across the regions. One important factor is the soil and forage quality of the pasture. This survey did not gather data on soil and forage quality, but the share of grazing land in the region serves as a sufficient proxy. Operations are divided into mutually exclusive groups, depending on whether 50 percent of their land is improved. Most regions had an even share of operations with improved grazing land. The Delta States and Southeast region, at 76 percent, have the largest proportion of land classified as improved grazing land (figure 10). Having the most improved grazing land could be one reason the Delta States and Southeast region have the largest average stocking density. However, more than 50 percent of the Southern Plains region has improved range land, but the stocking density is the smallest. Operations with rotational grazing have a larger share of operations categorized as improved land compared to the non-rotational operations in the same region.

Figure 10

Share of operations with improved land by region and by grazing system



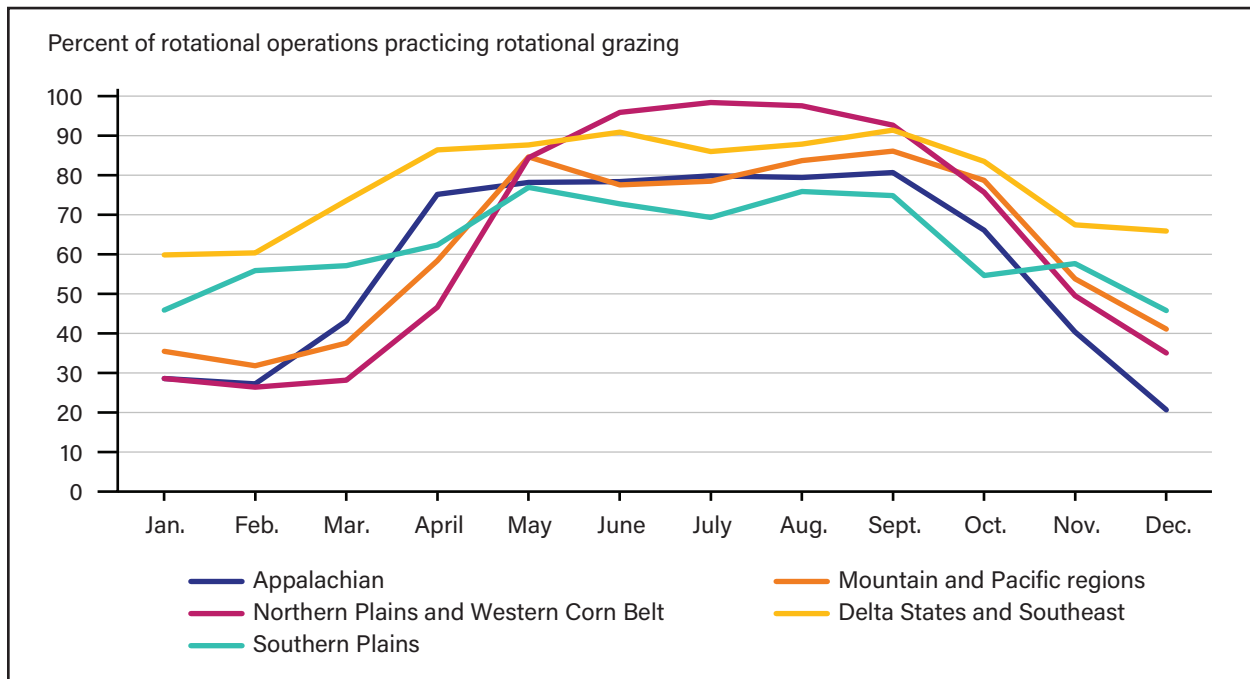
Notes: The Mountain and Pacific region consists of California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming. The Northern Plains and Western Corn Belt region consists of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. The Southern Plains region consists of Oklahoma and Texas. The Delta States and Southeast region consists of Alabama, Arkansas, Florida, Georgia, and Mississippi. The Appalachian region consists of Kentucky, Tennessee, and Virginia. Respondents self-report the amount of range and pastureland combined that is either unimproved or improved. Improvement can include use of fertilizer, seeding, irrigation, or other methods of increasing forage production or quality.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

The 2018 ARMS survey asked during which months operations practice rotational grazing and found that (in most regions) farmers and ranchers move cattle off the rotational grazing system from about November through March or April. However, in the Delta States and Southeast region, most rotational grazing operations utilize the system in the winter months. Feeding cattle during the winter months represents one of the largest costs associated with livestock production, thus operations continuing to practice rotational grazing during the winter months decrease costs from both harvest and purchase of feeding hay (Gates, 2020). Figure 11 shows the proportion of rotational grazing operations practicing rotational grazing by month for each region. Because the Northern Plains and Western Corn Belt regions have severe winter weather, it makes sense that in the winter months—December to February—the Northern Plains and Western Corn Belt have the lowest participation. However, during the summer months—June to August—the region had the most operations at over 90 percent practicing rotational grazing. The Southern Plains region is more arid, and it would be risky for these farms or ranches to maintain year-round grazing rotations (Heitschmidt et al., 1990), while other regions with more temperate winter weather (such as the Delta States and the Southeast region) can maintain rotational grazing systems through the winter.

Figure 11

Percent of rotational grazing operations practicing rotational grazing by month and region



Notes: The Appalachian region consists of Kentucky, Tennessee, and Virginia. The Mountain and Pacific region consists of California, Colorado, Idaho, Montana, New Mexico, Oregon, and Wyoming. The Northern Plains and Western Corn Belt region consists of Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota. The Delta States and Southeast region consists of Alabama, Arkansas, Florida, Georgia, and Mississippi. The Southern Plains region consists of Oklahoma and Texas. Operations that reported operating rotational grazing at any point in 2018 identified the months during which they had cattle on the paddocks used in that grazing system. During the other months, the cattle might be on pasture that is not part of the rotational grazing paddocks or being fed primarily with supplemental feed.

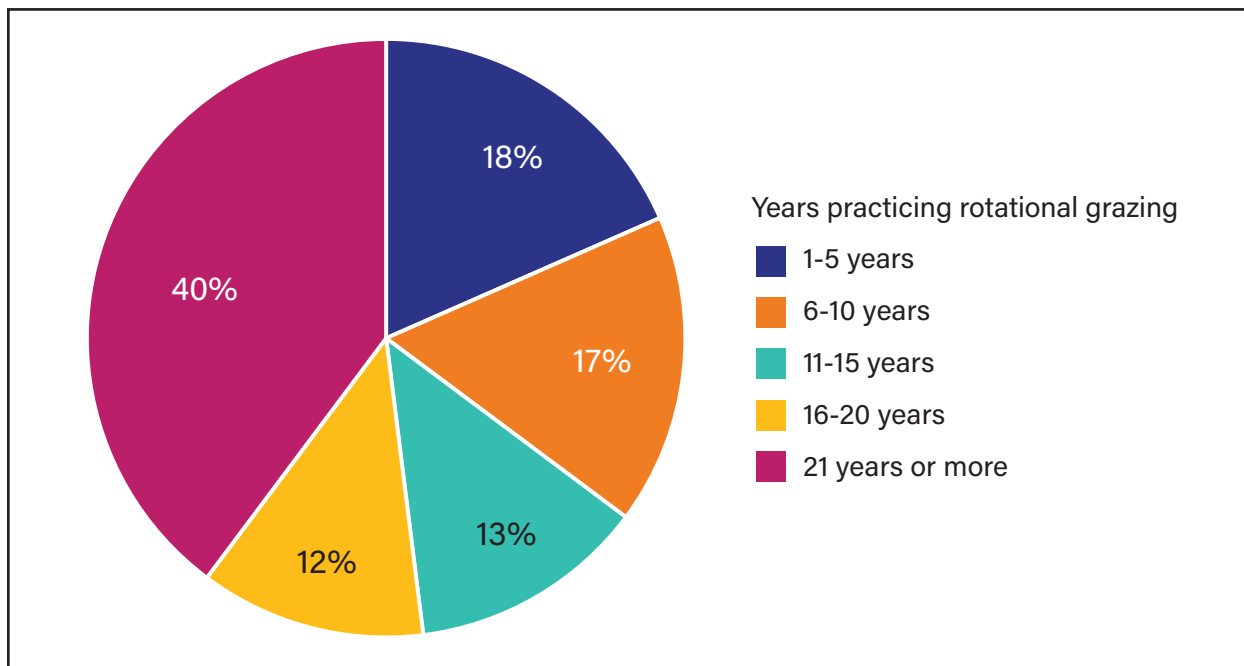
Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Variation in Rotational Grazing Management and Intensity

Due to the small sample size of cow-calf finishing operations, this section aggregates the three beef cattle operation types (strictly-calf, retained stocker, and finisher) practicing rotational grazing. More than half of rotational grazing operations have practiced rotational grazing for at least 16 years, and only 18 percent of the operations began in the last 5 years (figure 12).

Figure 12

Distribution of rotational grazing by number of years operations have practiced rotational grazing



Note: Operators that reported operating a rotational grazing system identified the number of years they have been using that system.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Fencing for rotational grazing requires a significant upfront cost and could explain the greater use of EQIP by IRG operations. Fencing costs are consistently USDA, NRCS’s largest share of total cost assistance for helping farmers and ranchers implement prescribed grazing, which includes more than rotational grazing practices. The large fencing costs imply a potential barrier to entry into NRCS programs for grazing operations. Rotational grazing operations primarily build permanent fencing; only 10 percent of BRG operations and 19 percent of IRG operations reported using temporary fencing (table 4). BRG operations are more likely to have permanent fencing compared to IRG operations. Operations can install irrigation systems to improve grazing land, but only a small share of BRG and IRG operations have any irrigated acres, at 6 percent and 10 percent, respectively.

Table 4

Percent of rotational grazing operations by management characteristics

	Basic rotational grazing	Intensive rotational grazing
Fencing type		
Temporary	10*	19*
Permanent	90*	81*
Irrigated acres used rotational grazing system		
Irrigated acres	6	10
No irrigated acres	94	90
Type of rotational schedule		
Variable system	78	70
Fixed system	22	30
Management decisions		
Test forage quality	22	27
Keep individual beef cow/calf records	57*	81*
Use an on-farm computer to manage beef cow/calf records	37	42

Notes: The asterisks (*) refer to the results of a pairwise t-test statistical tests between item values in each column. All tests are expressed at a 95-percent level of confidence. An asterisk denotes that the value reported in a row is significantly different from the value in the same row. The tests were conducted using a jackknife variance estimator, with 30 replications provided with the ARMS data.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey (ARMS).

When implementing rotational grazing, farmers and ranchers must decide if the operations will use fixed or variable schedules. A variable rotation system allows farms to adjust their rotation schedule based on rainfall and available forage. For example, a farm or ranch may graze beef cattle for more or fewer days, depending on the paddock's forage growth. In contrast, a fixed system describes when farmers and ranchers maintain a more rigid rotation schedule. When using the fixed schedule, the farmer or rancher graze their cattle on each paddock for the same number of days, regardless of rainfall or forage growth. Of the operations using rotational grazing, most operations opt for a variable system because it allows these operators to adjust the number of days that paddocks are grazed and rested based on forage availability and forage growth. The majority (70 percent and 78 percent, respectively) of IRG and BRG farmers and ranchers use a variable system compared to a fixed system.

Other operational decisions include testing pasture forage quality, maintaining individual cow/calf records, and using an on-farm computer to manage beef cow/calf records. About a quarter of IRG and BRG operations test the forage quality of their pastures, and IRG operations are more likely to keep individual beef cow/calf records (81 percent) compared to BRG operations (57 percent). However, only 37 percent of BRG and 42 percent of IRG operations use an off-farm computer to store the records.

The number and size of paddocks is a crucial component to consider when implementing rotational grazing and can affect how often beef cattle are moved, as well as potential environmental improvements to grazing land. The general pattern seen in table 5 is that IRG operations use a greater number of smaller paddocks on average, and BRG operations generally use a smaller number of large paddocks. The combination of frequently rotating cattle on many different paddocks can potentially minimize overgrazing of forage by allowing foliage or grasses to regenerate (Undersander et al., 2002). The majority (61 percent) of BRG systems use 2 to 5 paddocks. However, IRG operations are more likely to use (about 41 percent) 6 to 15 paddocks.

When implementing rotational grazing, it is recommended that farmers and ranchers focus on maintaining consistent forage availability across paddocks, not necessarily maintaining equal-sized paddocks (NRCS, 2009(a)). IRG operations also use smaller sized paddocks, with almost half using on average 19 acres or less per paddock, and the majority of BRG operations have paddocks that are 40 acres or more on average. When IRG operations use smaller paddocks, the beef cattle may graze the pasture uniformly, which could lead to more uniform pasture growth, reducing plant stress while improving forage quality and yield during the grazing season. The operations with paddocks of 40 acres or more do not follow the typical guidelines of an intensive grazing system and may see less improvement in soil, forage quality, or forage yield in the paddocks. However, the forage quality and availability on operations with larger paddocks might restrict the operations from creating small paddocks.

Table 5

Percent of rotational grazing operations by number of paddocks and average paddock size

Characters	Basic rotation grazing	Intensive rotational grazing
Number of paddocks		
2–5 paddocks	61*	36*
6–15 paddocks	32	41
More than 16 paddocks	7*	23*
Average paddock size		
19 acres or less	13*	49*
20–39 acres	29	20
40 acres or more	58*	31*

Notes: The asterisks (*) refer to the results of a pairwise t-test between item means in each column. All tests are expressed at a 95-percent level of confidence. An asterisk denotes that the value reported in a row is significantly different from the value in the same row. The tests were conducted using a jackknife variance estimator with 30 replications provided with the ARMS data.

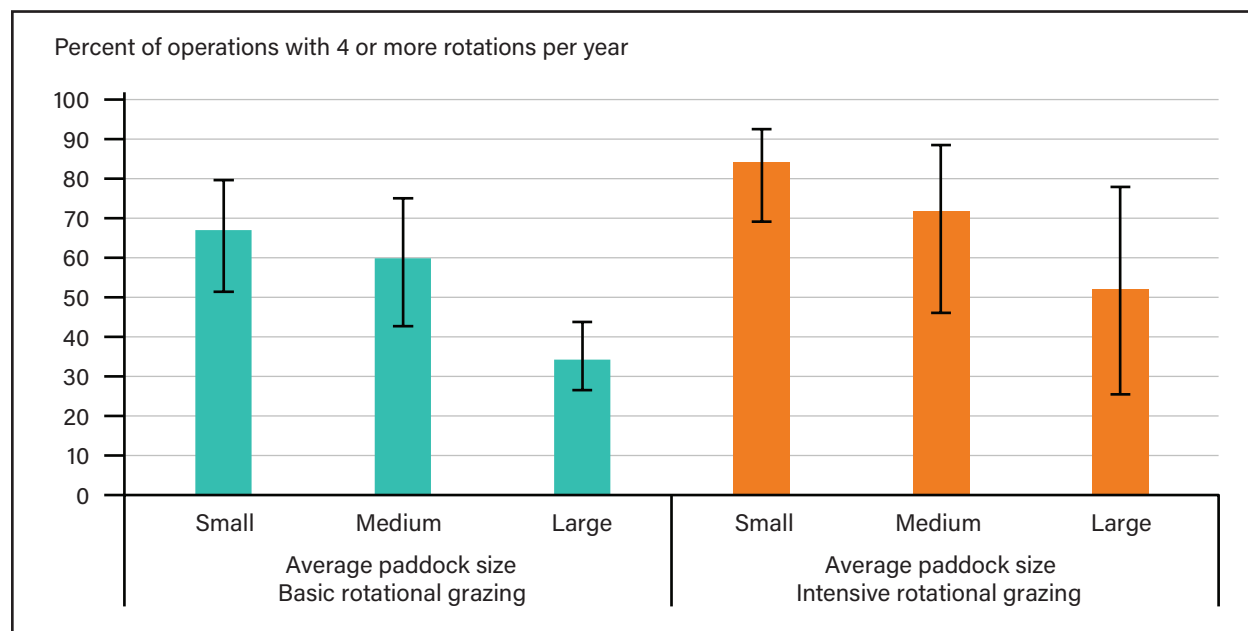
Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey (ARMS).

For a given size herd and pasture area, a distinct pattern exists between the number of rotations per paddock per year and the paddock’s average size between BRG and IRG operations (figure 13). A large share (84 percent) of IRG operations with paddocks of 19 acres or less (small paddocks) rotate their cattle, so each paddock received 4 or more rotations per year. As the average paddock size increases, the share of operations using 4 or more rotations per paddock per year decreases. The number of rotations per year depends on the size and number of paddocks in the grazing system. As the average paddock size increases, operations using 1–3 rotations per paddock per year increase. The share of IRG operations with an average paddock size of 20 to 39 acres (medium paddocks) and using 4 or more rotations decreased to about 72 percent, and for IRG operations with paddocks of 40 acres or more (large paddocks), the share of operations rotating on average 4 or more times a year decreases to 52 percent. This pattern was even more evident for BRG operations. About 67 percent of BRG operations with small paddocks use 4 or more rotations per paddock per year, but the share drops to 34 percent for BRG operations with large paddocks. The number of rotations per paddock per year depends on the size and number of paddocks in a grazing system. As demonstrated in figure 2 (given a set number of paddocks), a rotational grazing system can vary significantly in the length of the grazing period, which translates into different lengths of rest periods and numbers of rotations over the grazing season. Also, operators may choose to remove any number of paddocks from the rotation, for specific environmental or other reasons, at any point throughout the grazing season, which aligns with a large percent of rotational grazing operations preferring a variable rotation over a fixed rotational schedule. For example, if

the paddock contains plant parts that are toxic during a portion of the year, grazing in those paddocks would be deferred until the plants are no longer toxic. Other reasons can include but are not limited to high water tables or saturated soils, or habitat needs for sensitive species.

Figure 13

Percent of rotational grazing operations using 4 or more rotations per year by average paddock size



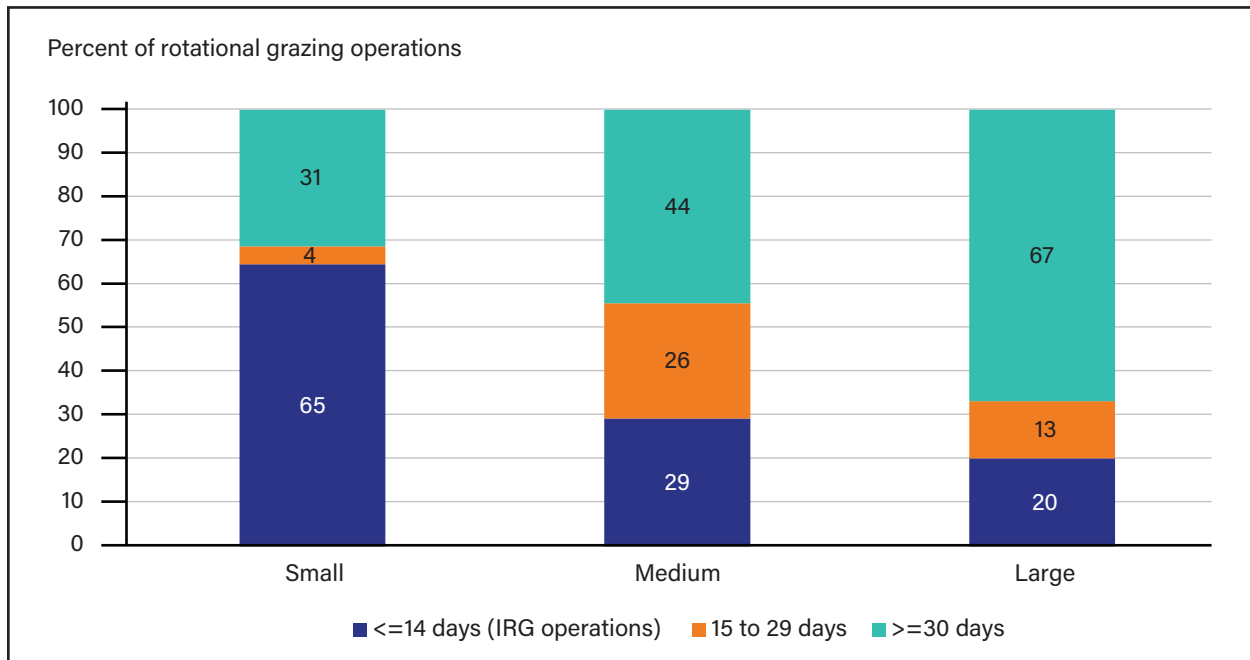
Notes: The line on the chart are 95-percent confidence intervals that are estimated using the jackknife replicate standard errors. Small paddocks are 19 or less acres, medium paddocks are 20 to 39 acres, and large paddocks are 40 or more acres.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

A clear relationship exists between the average number of grazing days per rotation and the average paddock size. Average grazing days per paddock depend on the amount of available forage in each pasture and can be influenced by the amount and timing of rain as well as air and soil temperatures. As the average number of rotations per year per paddock increase, the average grazing days per paddock increase (figure 14). Figure 14 also highlights that operations using small paddocks are more likely to practice IRG versus BRG. The share of operations rotating their cattle after 30 days or more increases from 31 percent on small paddocks to almost 67 percent of operations managing larger paddocks. The majority (65 percent) of rotational grazing operations using small paddocks are intensively rotating their cattle (14 or less grazing days per paddock), but when the average paddock size increases, a decline in the share of operations intensively rotating cattle is evident. Twenty-nine percent of operations on medium size paddocks intensively rotate cattle, and only 20 percent of operations intensively rotate cattle on larger size paddocks.

Figure 14

Rotational grazing operations by average grazing days and average paddock size



Notes: IRG= Intensive rotational grazing. Small paddocks are 19 or less acres, medium paddocks are 20 to 39 acres, and large paddocks are 40 or more acres. Due to rounding, not all percentages add to 100.

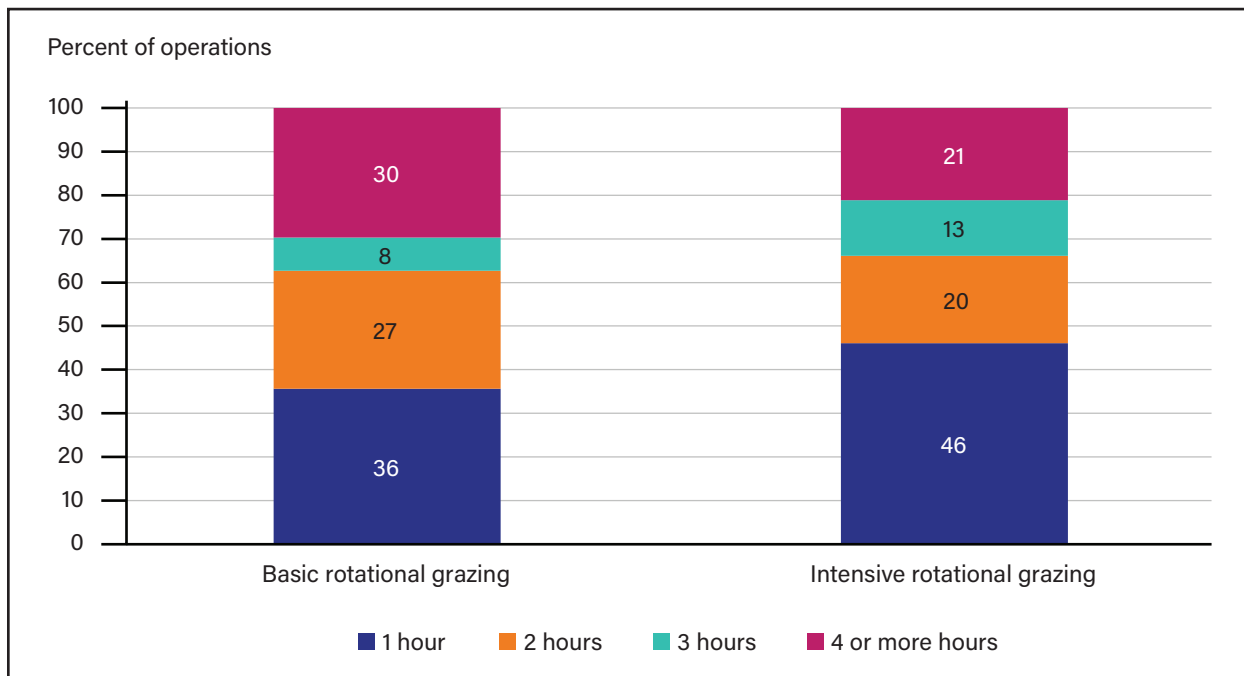
Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Variation in Time Spent Moving Cattle

Rotational grazing is often considered a more labor-intensive management practice. The layout and size of the pastures can affect how efficiently operators and ranchers move their cattle (Undersander et al., 2002). However, as figure 15 shows, 46 percent of IRG operations only spend 1 hour a week (on average) moving their cattle, compared to about 36 percent of BRG operations. Also, BRG operations were more likely than IRG operations to spend 4 or more hours (on average) a week moving cattle. The difference in time spent moving cattle could be related to BRG operations managing larger herds over more grazing land (on average).

Figure 15

Distribution of rotational grazing operations by average number of a hours a week spent moving cattle



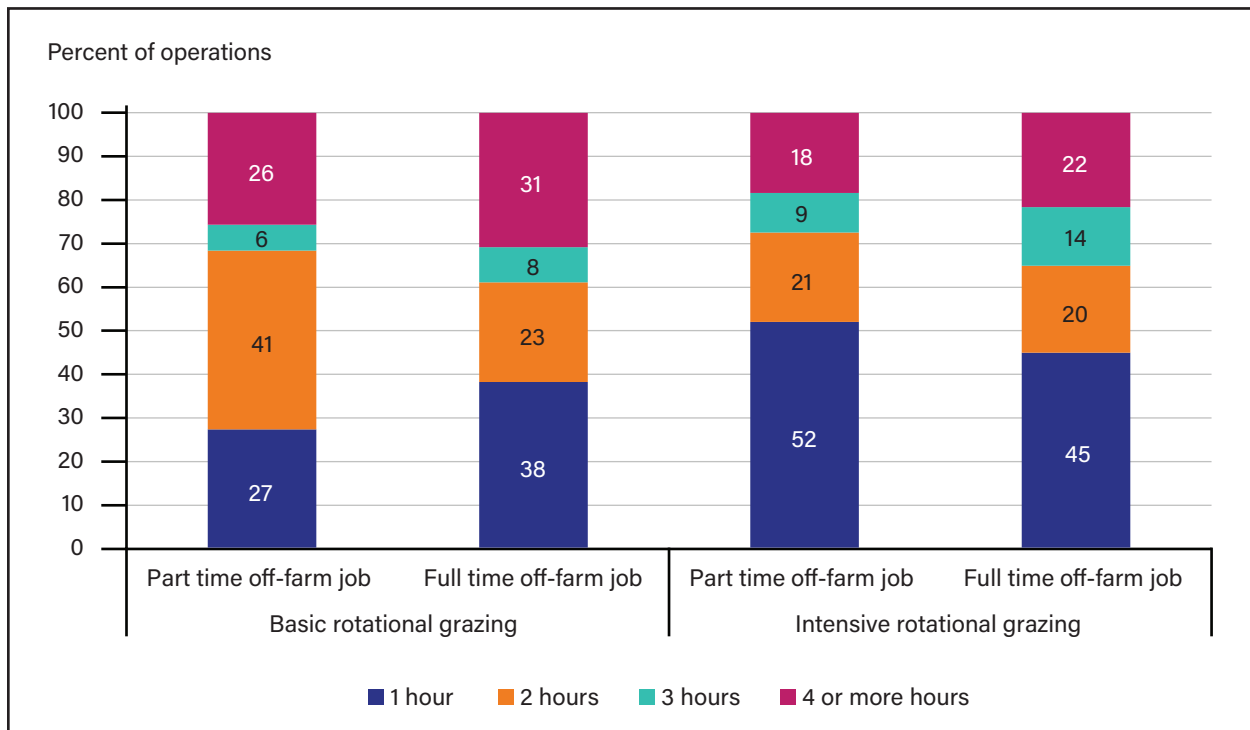
Notes: Operations that reported using rotational grazing indicated the average number of total hours per week spent moving cattle during the periods when the cattle are on those paddocks. Due to rounding, not all percentages add to 100.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Time spent moving cattle per week might influence the amount of time principal operators can dedicate to an off-farm occupation or be related to the number of cattle rotations per paddock per year (figure 16). However, the data do not show a clear relationship between a principal operator working a full- or part-time off-farm job and the average number of hours spent moving cattle per week for either IRG or BRG operations. Almost 52 percent of principal operators of IRG operations with a part-time off-farm job spend on average 1 hour a week moving their cattle, while about 45 percent of IRG operations (with a full-time job) spent on average 1 hour a week moving cattle. Also, only 22 percent of principal operators of IRG (with a full-time off-farm job) spent on average 4 or more hours a week moving cattle, while fewer (18 percent) IRG principal operators (with a part-time off-farm job) spent 4 or more hours on average moving cattle. The biggest difference between BRG full- and part-time principal operators is the share of operations spending 2 hours a week on average moving cattle. The absence of a clear pattern between a part- or full-time off-farm job and hours spent moving cattle indicates that there must be other rotational grazing systems, operation factors, or farm household factors that influence whether the principal operator has the time for a full- or part-time off-farm occupation. Rotational grazing is often considered a more labor-intensive management system; however, the results suggest that BRG operations spend more time on average moving cattle per week than do IRG operations.

Figure 16

Off-farm work by the average number of hours spent moving cattle per week



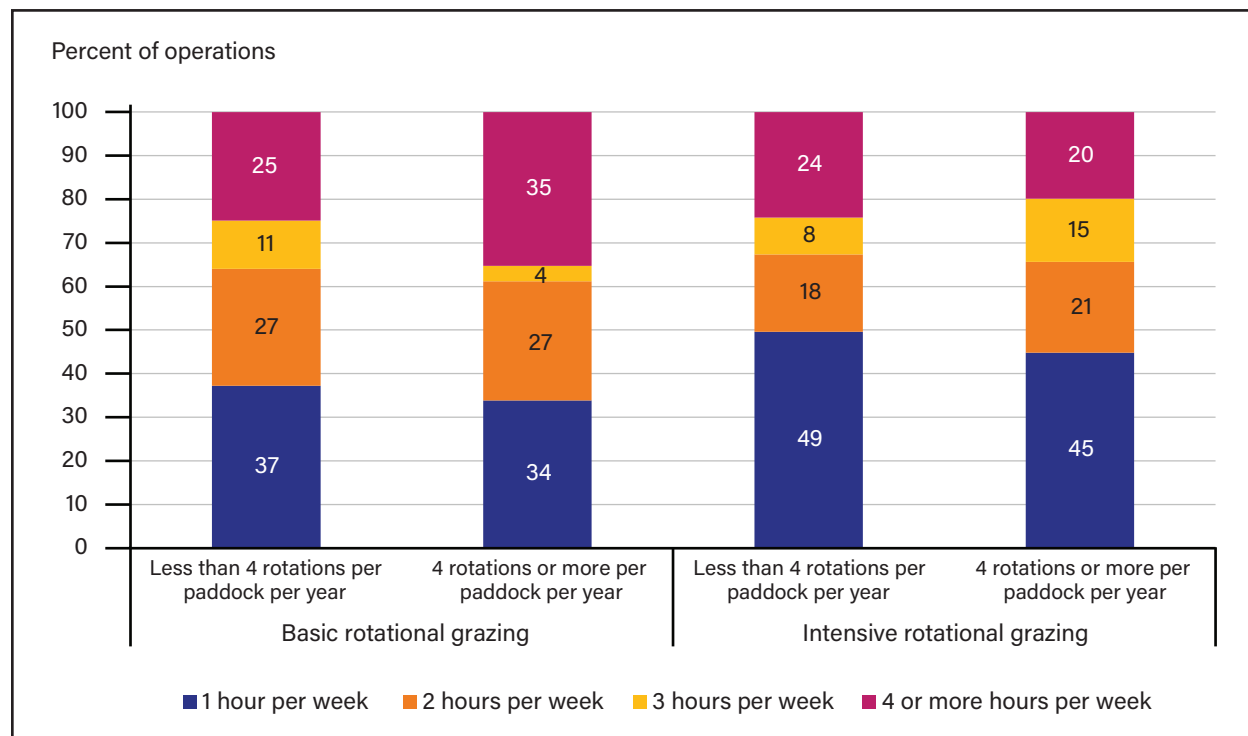
Notes: Operations that reported using rotational grazing indicated the average number of total hours per week spent moving cattle during the periods when the cattle are on those paddocks. Due to rounding, not all percentages equal 100.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Although no clear relationships were evident in figure 16, operations with less than 4 rotations per paddock per year spend (on average) 1 hour a week moving cattle, while operations with 4 or more rotations per year spend (on average) 3, 4, or more hours a week moving cattle (figure 17). These findings are consistent across IRG and BRG operations. Almost 50 percent of IRG and 37 percent BRG operations (with less than 4 rotations a year) reported only spending 1 hour a week (on average) moving cattle. However, 35 percent of IRG and 39 percent of BRG operations (with 4 or more rotations per year) averaged 3 or more hours a week moving cattle.

Figure 17

Number of rotations per year per paddock by the average number of hours spent moving cattle per week



Notes: Operations that reported using rotational grazing indicated the average number of total hours per week spent moving cattle during the periods when the cattle are on those paddocks. Due to rounding, not all percentage totals equal 100.

Source: USDA, Economic Research Service (ERS) using data from USDA, National Agricultural Statistics Service and USDA, ERS, 2018 Agricultural Resource Management Survey.

Conclusion

Prescribed grazing is one of the most well-funded USDA, NRCS practices for working lands conservation programs, particularly when including the funding for associated practices such as fencing and livestock water supply. This study presents one of the first nationally representative datasets that describes rotational grazing systems and variation in the adoption of basic and intensive rotational grazing for cow-calf operations in multiple regions. Such basic data on rotational grazing management strategies can facilitate future conservation policy analysis by focusing on the adoption, implementation, and management of grazing systems. Additionally, this study provides the foundation for future research to examine how grazing management is impacted by past and present conservation program financial assistance.

This study found that rotational grazing operations implement the practice at differing levels of intensity. While about 40 percent of cow-calf operations reported using rotational grazing, the authors found that most of these operations use basic rotational grazing systems. Only 16 percent of operations were found to be using intensive rotational grazing systems that had an average grazing period of 14 or fewer days per paddock per rotation. While this study relied on grazing periods to define system intensity, the authors also found that smaller paddock size and a higher number of paddocks are each closely associated with shorter grazing periods. Operations with a majority of their pasture having at least one form of improvement (use of seeding, fertilizer, or irrigation) are also more likely to practice IRG. Future conservation programs (such as carbon

offsets) that might seek to encourage IRG adoption could utilize these findings in the design of contracts and verification rules.

This study also found significant regional differences in rotational grazing adoption and grazing systems. The highest adoption rates for rotational grazing were in the Northern Plains/Western Corn Belt and Appalachia. Rotational grazing adoption is less common in the Delta States and Southeast region. The Appalachian region was the only region with more IRG adopters versus BRG adopters. Stock densities, which are influenced by both the grazing system intensity and the forage productivity, vary by region and within some regions. Rotational grazing operations in the Delta States and Southeast region have the largest average stocking density at 0.9 head per grazing land acre. In the Appalachian and Northern Plains/Corn Belt regions, IRG operations have a higher average stocking density than BRG operations. Use of the rotational grazing system over the course of a year also varies by region. In most areas, rotational grazing systems are not used from about November to March or April. During this time, operators could be feeding the animals hay or other types of supplemental feed. However, in the Delta States and Southeast region, most rotational grazing operations utilize the same system year-round.

Although rotational grazing has been cited as a “management intensive practice,” IRG operations spent less time moving cattle compared to BRG operations, but this could be a function of BRG operations operating more acres than IRG operations, on average. Most rotational grazing operations, regardless of intensity, spend on average 1 hour a week moving cattle. In addition, the average time spent moving cattle per week did not vary significantly based on whether the principal operator had a part-time or full-time off-farm job.

The data on the adoption of rotational grazing and differences in grazing systems outlined in this report show the complexity underlying the seemingly simple practice of rotating cattle through multiple paddocks. As conservation programs and other policies focus on expanding the adoption of prescribed grazing, the operation level details highlighted in this report on variation in management practice, such as number of paddocks and frequency of rotation, can provide a baseline against which to evaluate changes in grazing system management. Programs might also begin to set strategic goals that meet intensification objectives, go beyond basic practice adoption rates, and target specific management practices in different contexts—regions, operation types, and operation sizes.

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Appendix

Question page from the 2018 Agricultural Resource Management Survey Cattle and Calves Cost and Returns Report³

3. Does this operation use rotational grazing for beef cattle?

1 Yes - Continue 2 No - Go to Section Q

4. In what year did this operation start using rotational grazing? _____

5. Describe the details of the rotational grazing system:

a. How many paddocks does this operation use? _____

b. What is the average size (acreage) of each paddock? _____

c. How do you adjust your rotations?

1 Fixed 2 Variable

d. For a single rotation, how many days, on average, does the herd graze a paddock? _____

e. How many rotations does each paddock receive per year? _____

f. What is the number of resting days for each paddock between rotations? _____

6. Place an X in the boxes for the months during which the beef cattle are in this rotational grazing system.

Jan Feb Mar Apr May Jun

³ Questions 1 and 2 in Section P of the questionnaire pertained to acreage in different pasture categories and do not directly relate to rotational grazing systems.

Jul Aug Sept Oct Nov Dec

7. Does this operation use permanent or temporary cross-fencing?

1 Permanent 2 Temporary

8. During rotational grazing, how many hours per week, on average, are spent moving the animals? _____

9. How many acres in the rotational grazing system are irrigated? _____