Management-intensive Grazing (MiG) on Irrigated Pasture

Fact Sheet 1.635 Livestock Series | Management

By Casey Shawver, Joe Brummer, Jim Ippolito, Jason Ahola, and Ryan Rhoades (9/20)*

Quick Facts

- MiG emphasizes "intensive management" and not "intensive pasture use" by controlling grazing time and space to balance available forage with animal demand.
- Balancing grazing frequency and intensity with the opportunity for forage regrowth are core MiG principles.
- Determining pasture size incorporates estimates of forage supply and animal demand.
- Short- and long-term monitoring is integral for making management decisions to achieve goals and objectives more effectively.

What is MiG?

Management-intensive Grazing (MiG), a concept credited to grazing specialist Jim Gerrish, is often defined as "a flexible approach to rotational grazing management whereby animal nutrient demand through the grazing season is balanced with forage supply and available forage is allocated based on animal requirements" (4, 7). This type of system requires manipulating the length of time animals graze and space allotted based on available forage resources to achieve desired objectives. It also requires an understanding of how plant, animal, soil, and environmental components work together to make management decisions (4). MiG is often characterized by relatively frequent movements of animals, typically every 1-4 days (Figs. 1, 2). This method ranks MiG as more "management-intensive" than planned rotational grazing (3-10 day moves), but less so than mob grazing (2-10 moves daily).

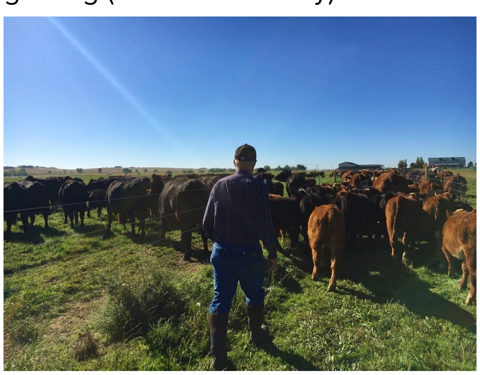

Figure 1: Daily cattle move in the irrigated MiG system at Colorado State University's research facility (Photo by Casey Shawver).

More intensive, irrigated systems are being considered as an option by many ranchers due to pressure to reduce grazing on public lands and the declining land available for pasture (2). Within intensive, irrigated pasture systems, MiG can result in more homogenous utilization of available forage, increased forage yield and quality, less severe soil compaction, improved soil health, and more evenly distributed manure and urine over an area leading to reduced production costs by providing increased animal output and greater land use efficiency (6, 8, 9, 10). At Colorado State University (CSU), an irrigated, full-scale MiG project was established in 2016. Experiences and lessons learned from this project are included within this document to provide further insight. Although some of the principles discussed in this document apply to management of native rangeland, keep in mind that there are also many differences, especially with respect to the potential for forage regrowth to occur under irrigated conditions compared to dry, native rangeland in the western US.

MiG Principles

Core components of MiG can be summarized by the FIO principle: minimizing frequency of plant defoliation (F), controlling intensity of plant defoliation (I), and allowing

Casey Shawver, Former Graduate Student, Joe Brummer, Associate Professor-Forage Extension Specialist, and Jim Ippolito, Associate Professor-Soil Fertility and Environmental Soil Quality, Department of Soil and Crop Sciences; Jason Ahola, Professor-Beef Production Systems, and Ryan Rhoades, Associate Professor-Beef Extension Specialist, Department of Animal Sciences. 9/20.

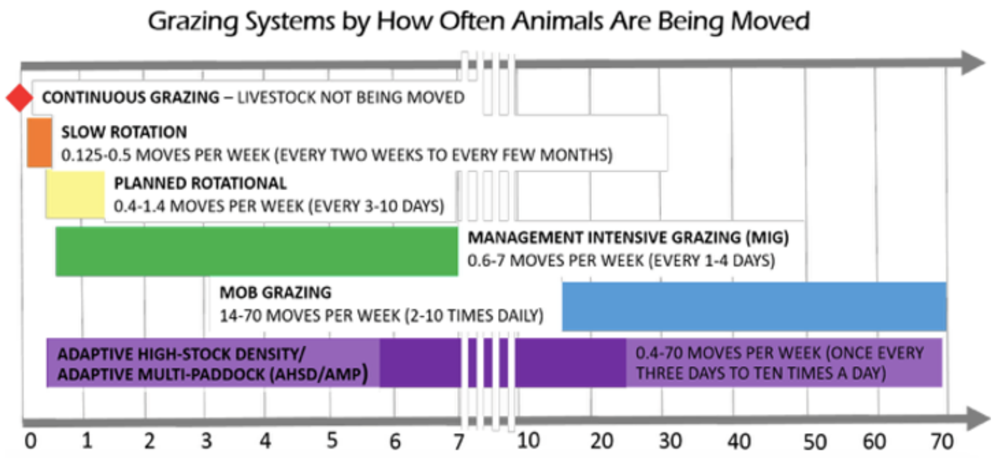

Figure 2: Diagram illustrating frequency of animal movements based on grazing strategy (Figure by the Pasture Project).

opportunity for plant growth/regrowth (O). These factors are all focused on maximizing productivity and utilization while protecting plant health to ensure long-term pasture productivity.

Frequency

MiG involves frequent movements that result in infrequent defoliation of individual plants. In contrast, allowing animals to spend time in an area for an extended period can lead to multiple defoliations of individual plants during a grazing event. Multiple defoliations of individual plants impact the energy balance between roots and shoots. This leads to weakening of plants, which ultimately results in reduced productivity and eventual thinning of the stand. Bare soil in a pasture is an open invitation for invasion by unwanted weeds.

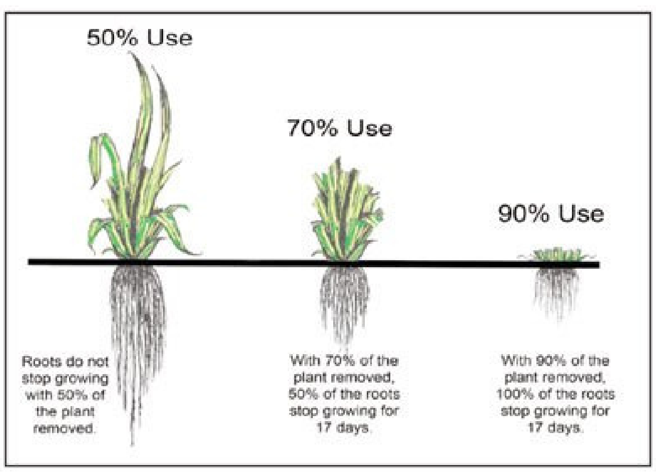

Figure 3. Illustration of forage utilization and its impact on root growth (Interpretation of research by Crider, 1955, Figure by Kathy Voth, Great "Grass Farmers" Grow Roots).

Intensity

Intensity of defoliation has direct impacts on rate of forage regrowth as well as overall root growth. When forage utilization exceeds 50%, regrowth and productivity slow due to reduced leaf area, which limits photosynthesis (3). In addition, root growth slows and will eventually cease at utilization levels greater than 50% (Fig. 3). Continued utilization above 50% will weaken plants, eventually leading to plant death and invasion by weeds. In addition, it is important to note that sufficient leaf area needs to be maintained to enable initiation of plant regrowth. The residual height at which sufficient leaf area is maintained varies depending on the grass species, however, most cool-season irrigated pasture grasses should not be grazed below 4 inches. Grazers often refer to these 4 inches as "belonging to the plant" to ensure energy is maintained for quick regrowth and overall plant health. As a general guideline, a minimum of 8 inches of forage should be available before grazing to assist in maintaining both the 4-inch residue height and 50% utilization objectives that will ultimately ensure adequate plant recovery.

Although 50% use is generally the desired target, there are circumstances in which lower or higher levels of utilization are warranted. Examples of when you might want to graze more intensively (>50% utilization) would be to remove more of the grass canopy to allow light to penetrate and stimulate growth of legumes like white clover or increase establishment success of interseeded forages. An example of when you might want to graze less intensively (<50% utilization) would be during spring growth when cool-season species grow rapidly and forage can begin to mature faster than it can be grazed. On the CSU grazing project, we found that it was important to move animals quickly through the first rotation early in the season, generally only utilizing 20-30% of available forage in an effort to remove growing points from some of the grass and keep it from jointing and becoming over-mature. In other words, since forage was growing rapidly in the spring, we moved livestock more quickly between units in response to conditions, whereas livestock spent longer time periods in each unit later in the year. This example illustrates the adaptive nature of MiG where we were monitoring plant growth rates and utilization levels in order to make decisions on when to move our livestock. The emphasis of MiG is on “intensive management” and not “intensive pasture use” which is why fixed grazing periods do not work well to maintain plant health and vigor.

Opportunity for Regrowth

The period of rest following a grazing event is vital for regrowth. In general, over-utilization results in decreased animal performance and the need for longer rest periods. Shorter grazing periods and proper utilization, as discussed above, can help mitigate the need for prolonged rest periods. In a cool-season, irrigated pasture system, the optimum rest period is not only dependent on grazing management practices, but also temperature, which is related to the point in time during the growing season. Cool-season grasses experience a period of slower growth during the hottest period of the growing season, also known as “summer slump.” During this period, length of the rest period should be longer to compensate for slowed growth (Fig. 4).

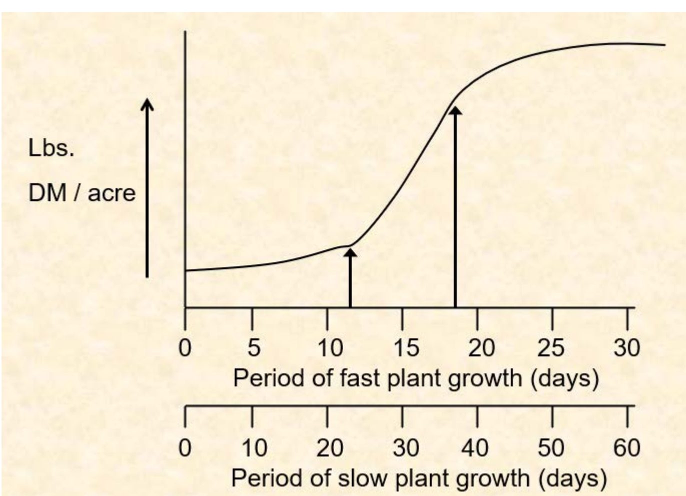

Figure 4. Optimum rest period (plus/minus a few days either side of vertical line on the right) for fast and slow plant growth periods to maintain plants in the most rapid growth stage (Craig Saxe, Univ. Wisconsin).

In the spring, cool-season species grow rapidly, requiring cattle to be moved quickly to keep up with growth as well as remove growing points before grass begins heading. The ultimate goal of determining a rest period is to maintain plants in their most rapid rate of growth (i.e. steepest part of growth curve in Fig. 4). This gives enough time for plants to recover and produce adequate forage before another grazing event, but not so long that plants become mature and quality and rate of growth begins to decline. The recommendations in Figure 4 are approximate and actual values are site dependent and can change based on environmental factors, primarily temperature and moisture.

The rest period on the CSU grazing project was not fixed and averaged around 30 days over the 6-month grazing season. The amount of regrowth is what we keyed on to determine if a paddock was ready to be grazed again. As mentioned above, a minimum of 8 inches of regrowth and a full (closed) canopy is what was targeted. Rest periods ranged from 18 to 24 days early in the season during rapid growth, to 35 to 40 days during the summer slow growth period, to 28 to 32 days later in the season when temperatures cooled and the rate of regrowth increased again.

Selecting Forage Species

There are many cool-season species that perform well under irrigated MiG. However, based on experiences from the grazing project at CSU, there are pros and cons associated with some of these species that need to be considered when choosing what species to include in a mixture and if altered management strategies are required for establishment and grazing.

Orchardgrass

Orchardgrass is commonly included in irrigated pasture mixes. It is a very palatable species that is high in quality and productive in an irrigated pasture setting. If including orchardgrass in a mixture with grasses such as meadow brome that have increased seedling vigor, include a higher percentage of orchardgrass seed in the mix. This will help mitigate competition between orchardgrass seedlings and more vigorous species such as meadow brome.

Meadow Brome

Meadow brome is also included in many irrigated pasture mixes and is very productive, nearly to a fault during early season growth. During early growth, meadow brome tends to joint (i.e. elongate stems) before most other cool-season grasses. If the growing points are not removed early with grazing, then meadow brome plants will set seed, which reduces palatability and utilization. Rapid rotation in con-junction with a high stock density (number of animals per unit area) is critical during the first 4 to 6 weeks of the growing season if meadow brome is included in the grass mixture. This is not as much of an issue with most other cool-season grasses.

Another issue with meadow brome is related to the morphology of its leaves which are soft and lax (i.e., not rigid, upright). During rapid spring growth, leaves become long (>20 inches) and tend to lodge or lay on the ground. When cattle enter a paddock to graze, the leaves are easily trampled. This was observed on the grazing project at CSU which resulted in the accumulation of dense layers of litter on the soil surface that slowed regrowth. Slowed regrowth can be a disadvantage in a MiG system resulting in paddocks where grazing needs to be delayed or skipped on the following rotation.

Tall Fescue

Although a common, productive irrigated pasture species, tall fescue is not very palatable to cattle if they have a choice within a pasture mix, especially when using the older, tough-leafed cultivars. This was observed clearly within our paddocks at CSU when cattle overgrazed other species and mostly avoided tall fescue in the mixture that contained one of the older cultivars. However, another species mixture on the project had a newer, soft-leafed cultivar of tall fescue that was not avoided by cattle. It was evident that the tough-leafed tall fescue deterred cattle and utilizing a soft-leaved cultivar can alleviate this issue. Older varieties of tall fescue are better utilized in monocultures or as stockpiled forage for fall/winter grazing to reduce selectivity.

Creeping Meadow Foxtail

Creeping meadow foxtail is a complementary addition to a cool-season pasture mix due to its rhizomatous growth habit. Many of the cool-season species used in irrigated pastures are bunchgrass types, which have generally less resilience to grazing. Grasses such as creeping meadow foxtail will fill in gaps between bunchgrasses over time to create thicker ground cover. Ground cover in a pasture is vital to maximizing productivity because bare ground is a missed opportunity for photo-synthesis and plant growth. Another quality that this species has is that it thrives in wet environments where other species cannot. If there are wet, low lying areas in your pasture, this species should be con-sidered for inclusion in the mix. One caveat is that creeping meadow foxtail can become dominant in areas such as high mountain meadows due to the wild flood irrigation method which creates saturated soil conditions conducive to growth of this species.

Smooth Brome

Smooth brome is rhizomatous and is often included in irrigated pasture mixes to help fill in bare areas between bunchgrasses to maintain thick stands. Smooth brome is very palatable and produces an abundance of forage during initial spring growth. However, it regrows slowly during the hot part of the summer which can limit forage availability, leading to the need to reduce stocking rates during that time. It can also lead to sod-bound conditions if it makes up too much of the stand, which results in reduced productivity. The key to including smooth brome in mixtures is to keep the percentage low, no more than 5 to 10% of the total mix (i.e., 1 to 2 lbs/acre). Even when seeded at low rates, smooth brome will often come to dominate a stand over time due to its aggressive spread through rhizomes. However, this can be minimized with proper grazing management that maintains the health and vigor of the bunchgrasses in the mix.

Perennial Ryegrass

Worldwide, perennial ryegrass is one of the most common grasses planted for improved pasture. However, most varieties do not persist well under Colorado's fluctuating environmental conditions and will often winterkill. Because it establishes quickly and easily, it is often included in irrigated pasture mixes but stands will tend to thin within 1 to 3 years. If you look at the tag on a typical seed mixture, perennial ryegrass will often make up 25% or more of the mix, which can result in significant declines in productivity as it disappears from the stand. Several seed companies are working on cultivars adapted to Colorado's continental climate, so be sure to ask where the cultivar in the mix was developed. Otherwise, be wary and keep the percentage in the mix to a minimum.

Assessing Forage Availability

Estimating how much forage is available is an integral step prior to determining paddock size. One of the simplest, most affordable, and quickest methods is measuring average sward height with a pasture/grazing or yard stick (Fig. 5). To utilize this method, choose a pattern that you will take measurements along (e.g. walk the pasture in an "M", "S", or "Z" pattern) to eliminate bias of certain areas of the pasture. When taking your first measure-ment, place the measuring stick into the grass and record the height below which 90% of forage mass is found. You do not want to measure the tall, wispy leaves or pull the grass leaves up to the stick. If this method is practiced enough, you can calibrate yourself to visually estimate available forage in our pastures. While walking, take measure-ments at regular intervals so that you collect 20-30 values. Take an average of the measurements to determine sward height. Generally, in a cool-season irrigated pasture with 75-90% ground cover, 250-350 pounds of forage dry matter (DM) per acre are available per

Figure 5. Demonstrating sward height measurement with a pasture/grazing stick (Photo by Ariel Bobbett).

inch of sward height. Multiply the average sward height by the pounds of DM per acre inch to estimate yield in pounds per acre. It is a judgement call as to what yield per inch of height to use. If the ground cover is a little sparse (~75%), then use 250 lbs/acre/inch but if it is a nice dense stand (~90% ground cover), then use 350 lbs/acre/inch. Remem-ber that this is just a ballpark estimate, so using the midpoint of 300 lbs/acre/inch will provide an acceptable estimate in most situations. Other methods such as the rising and falling plate meters are also reliable options for estimating forage yield. More information on these methods can be found in Pasture and Grazing Management in the Northwest by Shewmaker and Bohle (10). Note that these methods work best in areas of relatively uniform vegetation, like irrigated pasture, but do not translate well to estimating available forage on dryland pastures or rangelands with sparse plant cover (<60%).

Infrastructure

Common pasture infrastructure in an irrigated, MiG system includes barbed wire or high-tensile electrified perimeter fence, electrified polywire and step-in posts used to establish cross fences, waterers, and gates. Infrastructure design and day-to-day setup varies by ranch; however, the common concept is utilizing moveable fence and posts to create paddocks based on forage availability and animal demand. Moveable, temporary fence makes this system extremely flexible depending on how quickly forage is growing or how many animals are being grazed at a point in time. Animal demand and forage supply are in a constant state of flux and it is important that the infrastructure can adapt to account for that variability. In the system installed at CSU, three concentric, permanent, electrified high-tensile fences create the foundation within a 200-acre pivot, while electric polywire is connected from outer to inner circles to create temp-orary paddocks of varying sizes based on number of animals being grazed and current forage supply (Fig. 6). This is an effective fence design for a pivot system of this size, particularly when managing multiple herds. The three-ring fence design allows flexibility to graze up to 3 herds simultaneously within a given quarter of the pivot while having access to separate watering points and allowing for irrigation on the other 3 quarters (Fig. 6).

Figure 6. MiG system design on a 200-acre pivot including high-tensile concentric fences (green), moveable polywire paddock fencing (white), and watering locations at Colorado State University. Polywire locations represent areas associated with given water points and are often further subdivided into 2 or 3 smaller paddocks depending on animal numbers and current forage supply (Figure by Casey Shawver, retrieved from PastureMap mobile application).

Determining Paddock Size and Stocking Rate

The paddock size needed to balance forage supply with animal demand can be determined through two simple equations (Fig. 7). For the first equation, forage supply is determined by multiplying estimated available forage (using the pasture stick, etc.) by the utilization goal (generally 50%). Animal demand is then determined by multiplying estimated daily intake as a percent of body weight (be sure to use the decimal fraction) by the number of days planned to graze. The percent of body weight value changes based on cattle characteristics (e.g. sex, reproductive state, and age) (Table 1). Steers and heifers will generally consume between 3 and 3.5% of bodyweight. Then, forage supply is divided by animal demand to get pounds of liveweight per acre. In the second equation, total pounds of liveweight (average animal weight x number of animals) is divided by the pounds of live-weight per acre (answer from the first equation) to get the size of paddock in acres. Once the area is deter-mined, the paddock can be constructed using poly-wire and step-in posts. However, knowing where to set the fence(s) to achieve the desired area can be difficult. There are numerous free phone apps that use GPS and can measure land area while in the field (e.g. Geo Measure, GPS Fields Area Measure, etc.). Paid apps, such as PastureMap, are designed specifically for grazing systems and offer the paddock building tool as well as recordkeeping, grazing reports, and many other options. This is the tool we used and found it very useful. An example of the map you can create of your pasture layout can be found in Figure 6.

If you are not into technology, you can always just pace off, count fence posts, etc. to estimate the area to fence off for a paddock and then evaluate your level of use the next time you go out and adjust the size of the next paddock accordingly (i.e., larger, about the same, or smaller). Regardless if you do or do not use technology, visual estimation of utilization should be part of your daily monitoring followed by subsequent adjustment of paddock size or time in a paddock.

Although it is important to accurately estimate paddock size, please keep in mind that you also need to estimate and set a realistic stocking rate based on what the pasture will produce over the growing season. Changing paddock size and speed of the rotation will not make up for a deficit in forage production if you have too many animals. The first equation in Figure 7 can be used to estimate stocking rate for your pasture in lbs of

Calculating paddock size:

$$\frac{\text{Available forage estimation (lbs DM acre) x .50 (utilization goal)}}{\text{Estimated daily intake (\% bodyweight) x Duration of grazing (days)}} = \textbf{lbs of liveweight acre}$$

$$\frac{\text{Total lbs of liveweight for entire herd}}{\text{lbs of liveweight acre}} = \textbf{Size of paddock in acres}$$

Figure 7. Equations to calculate paddock size based on animal and forage information.

liveweight per acre. Instead of the amount of forage available at a point in time when determining paddock size, you need to use what you think the pasture will produce over the growing season. At lower elevations (below 6,000 ft), it is generally safe to assume that most well managed irrigated pastures in Colorado will produce at least 4 tons or 8,000 lbs per acre. As you move up in elevation, production will decline due to the shorter growing season down to 1.5 to 2 tons per acre at around 8,000 ft. For utilization, you can conservatively assume about 70% of what is produced over the growing season will be utilized by the livestock. At any point in time, you do not want to use more than about 50%, but when you add up utilization from all grazing periods over the season, it will generally total 70% or more of what was produced. Use the average intake over the season for the type of animals you will be grazing and how many days they will graze (e.g., 6 months or 180 days). In our system at CSU, the approximate stocking rate was 1,000 lbs of liveweight per acre (i.e., 1 animal unit per acre). To arrive at this value, we assumed 8,000 lbs/ac, 70% utilization, 3% bodyweight intake (be sure to use the decimal fraction, 0.03), and 180 days of grazing which equates to 1,037 lbs of liveweight per acre. This estimate proved to be very close for our situation.

Table 1. Pounds of dry matter intake (DMI) by a mature cow at varying weights and reproductive stages (5).

Body Weight (lbs)	Post- Partum	Lactating & Pregnant	Gestating	Pre-Calving
	DMI (% of Bodyweight)			
1100	2.62	2.51	2.13	2.27
1200	2.76	2.65	2.28	2.44
1300	2.91	2.80	2.43	2.58
1400	3.04	2.94	2.56	2.73

Pasture Monitoring

Pasture assessment over the short- and long-term is important for making management decisions to achieve goals. Examples of goals that we had for the CSU grazing project included:

- maintaining an average residue height of 4 inches following grazing to ensure adequate leaf area for photosynthesis and rapid regrowth
- utilization of 50% or less of the vegetation in a paddock during a grazing period
- rest periods no shorter than 18 days (preferably 21 days) with an average over the grazing season of about 30 days
- cows that maintained or increased in body condition over the grazing season
- calves that weaned as heavy or heavier than average
- minimal animal health issues

Table 2 outlines some of the factors to consider monitoring, what those factors tell you, how often to monitor, and monitoring methods.

Short-term assessments can be done visually when animals leave a pasture to determine if residue height/utilization goals are being met and assess livestock health. Moving animals more often allows managers to have a more intimate knowledge of weight gain/body condition status or illness within the herd. This information can be used to make more responsive improvements to the system. Pasture productivity can be assessed less frequently, approximately twice per month. This monitoring provides an idea of what forage production looks like moving forward in the grazing rotation and how forage is regrowing from previous grazing events. Longer term monitoring, which can be done once to a few times a season, focuses more broadly on overall pasture health. Observations in this type of monitoring could include plant diversity, basal cover, residue, fertility, soil characteristics, and others. There are several score sheets that can be used to record pasture observations and aid in determining overall pasture health. The Pasture Condition Scoresheet published by the NRCS is one good example to check out (1).

Challenges

When grazing cool-season irrigated pastures, one of the biggest challenges is balancing livestock forage demand with available forage throughout the season as both are always changing. As hard as one might try, it is difficult to rotate fast enough in the spring to keep up with rapid forage growth. Grass in some paddocks will end up transitioning to the reproductive phase and palatability and forage quality will decline. There are several options to address this issue. One is to have a flexible herd size with more animals available for grazing in the spring. If you are primarily grazing cow/calf pairs, you could also run some additional stocker steers for a couple of months. If you are running stocker steers, you could have a larger number in the

Table 2. List of monitoring indicators, what they tell you, suggested frequency of effort, and method to accomplish.

Monitoring Indicator	What It Tells You	Frequency of Effort	Method
Dry Matter Yield	Amount of forage present to inform paddock size	2x per month	See above – Assessing Forage Availability
Residue Height	Intensity of utilization - does enough leaf area remain for photosynthesis and rapid regrowth, does paddock size need to be adjusted	At every move	Pasture/grazing stick measurement combined with visual assessment to determine if the minimum 4-inch residue height was achieved
Body Condition	Weight gain/loss	Beginning and end of grazing season	Body condition score or actual weight
Animal Health	Need to treat an animal or remove it from the herd	At every move	Visual assessment of such things as droopy head/ears, lameness, slow to move to new paddock, etc.
Trend Monitoring	General ecological trend to determine if changes in management are required to maintain pasture productivity and stability of the plant community, soil, and water resources	Once per season at about the same time every year	See Pasture Condition Scoresheet by NRCS

spring and either sell the larger ones after a couple of months or move part of the herd to other forage re-sources such as native rangeland. A second option is to stock the pasture for when forage supply will be at its lowest point, which will be during the summer slump in July and August, and plan on haying some of the paddocks. The third option is to allow the forage in some paddocks to stockpile during June which will provide a reserve to help make it through the summer slump in July and August. We found that although palatability of standing, stockpiled forage declines significantly, if you mow the stand just prior to turning cattle into a stockpiled paddock that animals will do a good job of cleaning up the mowed forage. It has that nice smell of freshly cut, curing hay which draws animals to it. They will eat much of the cut forage along with grazing some of the leaves down in the canopy. We found that mowing between 6 and 10 inches (i.e. stubble height) with a rotary mower was ideal and led to quick regrowth of the forage which was nice and leafy by the next rotation through the mowed paddock.

A final consideration to keep in mind is that, although cool-season forages will regrow in the late summer/early fall, the amount and rate of regrowth will drop off quickly in late September into early October in Colorado. This means that the grazing season will generally be over by the end of October unless you have set aside paddocks earlier in the season (i.e. August) for stockpiling of forage. If grazing later into the fall is an objective, then having about a quarter of the area in monoculture tall fescue is a good option since it grows later into the fall, stands up well under a snow load, and stockpiles well (i.e., maintains forage quality). When grazing late in the growing season, you want to leave at least 4 inches of stubble for the plants to have enough stored carbohydrates to ensure survival and vigorous spring growth. Grazing too close (i.e., less than 4 inches) in the fall will lead to weakened stands the following year that green up later in the spring and are not as productive. Just like earlier in the growing season, you must "leave some grass in the fall to grow some grass the next spring".

More information on MiG can be found at:

1. Management-intensive Grazing: The Grassroots of Grass Farming by Jim Gerrish
2. Pasture and Grazing Management in the Northwest by Shewmaker and Bohle: https://www.extension.uidaho.edu/publishing/pdf/pnw/pnw0614.pdf
3. Management-intensive Grazing in Indiana, a Purdue/NRCS publication: https://www.extension.purdue.edu/extmedia/AY/AY-328.pdf

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