Extension
UNIVERSITY OF WISCONSIN–MADISON

grassLAND 2.0 ACADEMY

Grazier's Math: Calculating Carrying Capacity

UW-Madison Division of Extension

Why Carrying Capacity Matters

Carrying capacity could be the most important concept in all of livestock agriculture. It is carrying capacity, specifically *incorrect* carrying capacity, also known as "overstocking", that drives most of livestock agriculture's environmental problems today. Also commonly referred to as "stocking rate," carrying capacity is the number of animals a parcel of land can support by providing adequate feed and retaining and recycling the nutrients they produce. In grazing systems, where livestock harvest their own feed and spread their own manure, carrying capacity is foundational to a long grazing season that results in healthy animals, healthy pastures and a healthy ecosystem.

A primary goal of every grazing operation should be to maximize the length of the grazing season. This is directly correlated to profit because grazed forages are the most inexpensive source of feed, and stored feeds are almost always the greatest expense. Management helps determine grazing season length. The principles of managed grazing – the *Three R's* of rotation, residual, and rest – drive pasture yield and quality and have a significant impact on the farmer's ability to lengthen the grazing season. But the Three R's only work when we get the *carrying capacity* right.

Farms that fail to determine carrying capacity correctly can be overstocked and run out of pasture before the end of the growing season or be understocked and grazing fewer livestock than the land could support, both resulting in reduced revenue.

Many factors influence carrying capacity. Some are inherent, such as soil type, topography, and climate. Others are choices, such as livestock class, management, and operational goals, like whether winter feed is produced on-farm or purchased off-farm.

Figure 1. *Calculating carrying capacity is a critical step to successful grazing.*

Factors Influencing Carrying Capacity

The first step of determining carrying capacity is collecting information unique to the farming operation. The factors are broken into two groups – those that are more "foundational" to the particular type of livestock operation and are not likely to be changed, and "decision factors" that a farmer must determine from year to year.

Foundational Factors:

Grazing Management

Frequency of rotation has a significant impact on pasture yield. The more often animals are moved, the higher the overall yield will be. For this calculation, a minimal three-day rotation is assumed.

Soil Type

Wisconsin is well-known for its diversity of soil types. Within a farm, and even within a pasture there can be multiple different soil types. Soil type strongly influences pasture yield. When calculating carrying capacity, the predominant soil type is most relevant. This information can be found at the Web Soil Survey.

Land Base

The total acreage used for determining carrying capacity should include any acres intended to be grazed during the grazing season. Any additional acres that are not used for livestock feed should not be included.

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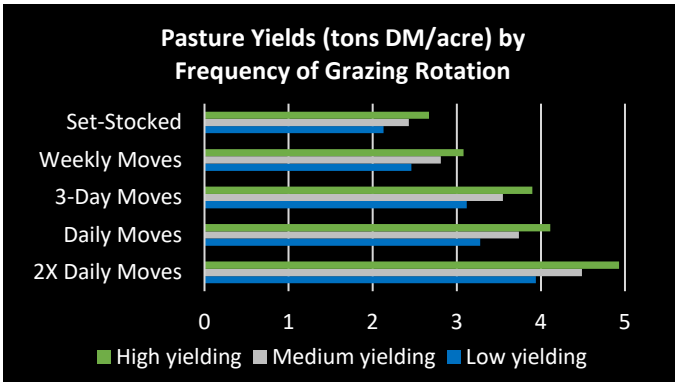
Forage Yield

Some farms with a history of growing crops on their land have a good idea of the average forage yield on their operation. Obtaining accurate yield estimates can be challenging. In the absence of accurate yield estimates, it is acceptable to utilize average forage yields for the region and soil type. This information is also at the Web Soil Survey, in the Soil Data Exporer under "Vegetative Productivity."

It is very important to use *dry matter* yield per acre, and not wet or as-fed yields, because these are highly variable from differences in moisture content. Dry matter yield addresses these variations by correcting for moisture. Further, animal intake predicitons, which will be covered later in this publication, are all based on intake of dry matter.



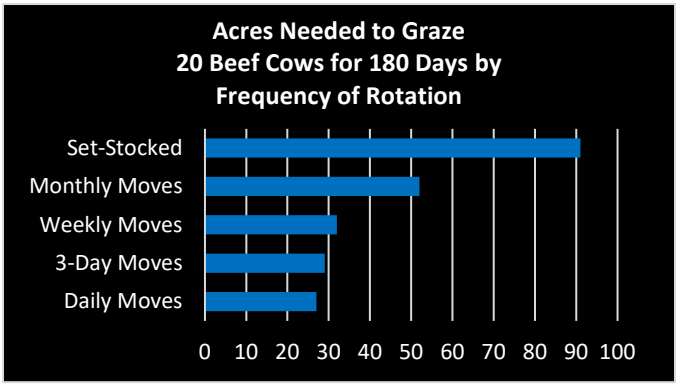


Figure 2. *Pasture yield and carrying capacity for pastures established under various forms of grazing management. More frequent rotation leads to greater annual forage production (top) and less land required (bottom). Pasture yield data from UW-Madison (Chasen, 2023) and acreage requirement estimates from USDA-NRCS Forage Animal Balance Worksheet.*

Animal Weight

Animal weight can vary drastically from farm to farm and even within a particular farm. To calculate carrying capacity, the average animal weight for the herd or flock is used. It is advisable to stay conservative (overestimate animal weight, underestimate yield) with this estimate, as it is more costly to overestimate than to underestimate carrying capacity. As with forages, many farms may not know the weights of their animals, but using standard values for different livestock classes is sufficient (for example, see Table 1).

Forage Intake

"Intake" is a term that refers to how much feed or forage an animal consumes in a day. In general, most livestock consume about 3% of their body weight in dry matter per day. Since grazing is not as "efficient" as other methods of feeding, and farmers are encouraged to leave behind residual forage, it is often suggested to use 4% of body weight for calculating carrying capacity.

Livestock Class	Average Weight	Intake (lbs DM/day)
Beef Bulls	1500	60
Beef Calves	400	16
Beef Cows	1300	48
Beef Stockers	900	36
Beef Yearlings	800	32
Dairy Heifers	800	32
Dairy Cows	1300	52
Goats	150	6
Lambs	75	3
Sheep Ewes	150	6
Rams	200	8

Table 1. *Forage dry matter intake estimates based on 4% of body weight for each class of livestock. Actual values will vary from farm to farm depending on age, breed, and genetics, but those listed in the table can be utilized when actual values are not known.*

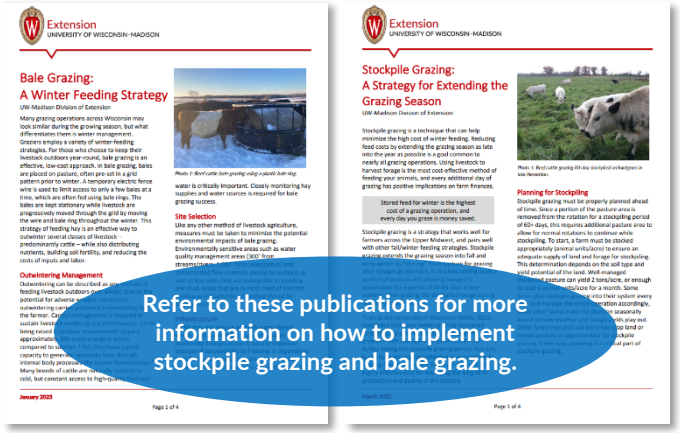
Decision Factors:

Length of Grazing Season

The goals of each farm will vary, but most grazing operations interested in maximizing the grazing season have a goal of at least 180 days (6 months) of grazing. The irony of this value is that it is directly influenced by the farm's actual carrying capacity.

Stockpile Grazing

Stockpile grazing is one tool that can extend the grazing season and reduce costs by reducing the amount of sored feed needed. If a farm does not stockpile graze, this section can be ignored. Farms that do practice stockpiling need to determine the number of days they hope to stockpile graze. This is commonly 30-60 days.



Stored-Feeding Season Length

No one can determine how long winter will be, but every farmer must estimate the number of days needed to feed livestock. Many grazing operations "outwinter," or feed on pasture through the winter. One of the most common methods of feeding hay through the winter is bale grazing (see the Extension publication: *Bale Grazing: A Winter Feeding Strategy*). For calculating carrying capacity, the duration of the stored-feed season will be the number of days remaining after the sum of grazing and stockpile grazing days are subtracted from 365 days. Many grazing farms with goals of 6 months of grazing and 2 months of stockpile grazing plan for 245 total grazing days and 120 days of stored feed.

Farm Information	
Predominant soil type (use Web Soil Survey)	
Land base for grazing (acres)	
Average forage dry matter (pounds/acre)	
Average animal weight (pounds)	
Grazing season length (days)	
Stockpile grazing length (days)	
Stored-feeding length (days)	

Crunching the Numbers

When it comes to putting these numbers to work, calculating carrying capacity is a step-by-step process involving multiple interconnected factors. For example, a farm custom-raising dairy heifers for the summer will have a much greater carrying capacity than a farm raising beef cows and calves because they need not account for acres for hay production. On the other hand, some farms employing winter-feeding may choose to purchase all hay to increase carrying capacity. These examples demonstrate how each step provides an opportunity for farmers to consider their options. Financial components of these decisions are not addressed here but must be part of the process. For example, some farms may consider alternatives to stockpile grazing for extending the grazing season such as annual cover crops, crop residues, etc. The calculations on the following pages will help to determine carrying capacity based on the various decisions available to the farmer.

Figure 3. *The process of calculating each component of carrying capacity is an opportunity for farmers to consider options such as making hay or stockpile grazing.*

Once the farm information is collected, calculating carrying capacity is a step-by-step process. Each step determines a different factor that helps the farmer consider operational options and decisions. The following factors are determined in the process:

1. Dry matter required per head
2. Growing season acres required per head
3. Stockpile grazing acres required per head
4. Hay production acres required per head
5. Carrying capacity for the growing season
6. Carrying capacity for growing season + stockpile grazing (extended season grazing)
7. Carrying capacity for extended season grazing + hay production (stored winter feed)

1. Dry Matter Requirement Per Head

	X		=	
Forage lbs dry matter per acre		Total acres for grazing		Total forage dry matter available annually
	X		=	
Average animal weight		Dry matter requirement by % body weight		Total dry matter requirement per head per day

2. Growing Season Grazing Acreage Per Head

	X		=	
Average daily need per head		Number of days growing season grazing		Total dry matter need per head for growing season
	/		=	
Total dry matter needed per head for growing season		Average dry matter yield per acre		Total acreage needed per head for growing season

3. Stockpile Grazing Acreage Per Head

	X		=	
Average daily need per head		Number of days stockpile grazing		Total dry matter needed per head for stockpile grazing
	/		=	
Total dry matter needed per head for stockpile grazing		Average dry matter yield per acre		Total acreage needed per head for stockpile grazing

4. Hay Production Acreage Per Head

	X		=	
Average daily dry matter requirement per head		Number of days of feeding hay		Total dry matter needed per head for feeding hay
	/		=	
Total dry matter needed per head for feeding hay		Average dry matter yield per acre		Total acreage needed per head for feeding hay

5. Carrying Capacity for Growing Season Grazing

	/		=	
Total acreage available		Acreage per head		Carrying capacity for growing season

6. Carrying Capacity for Extended Season (Growing Season + Stockpile) Grazing

	/		=	
Total acreage available		Acreage per head		Carrying capacity for growing season and stockpile grazing

7. Carrying Capacity for Extended Season Grazing + Hay Production

	/		=	
Total acreage available		Acreage per head		Carrying capacity for growing season and stockpile grazing

Carrying capacity is foundational to the success of livestock agriculture, balancing land stewardship with financial goals. Determining what the land can support is not just an ethical responsibility, it's the first step toward a synergistic relationship among the farmer, the livestock, and the land.

Extension publications:

- Bale Grazing: A Winter Feeding Strategy
- Stockpile Grazing: A Strategy for Extending the Grazing Season
- Pastures for Profit: A Guide to Rotational Grazing

These publications can be found at the UW-Madison Extension Crops & Soils Grazing Topic Hub
https://cropsandsoils.extension.wisc.edu/grazing/

To find soil type and forage production estimates:

- Web Soil Survey (https://websoilsurvey.nrcs.usda.gov/app/)

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Chasen, E.M. 2023. Predicting pasture yield in Wisconsin: Yield potential predicted by soil, grazing management, and grass species-clover mix. Web-application. Grassland 2.0 project. University of Wisconsin-Madison. https://conect.doit.wisc.edu/pasturePrediction.