Pasture Allocation

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This is the grass business

- Focus on building capacity before worrying about utilization

Stocking rate

- Demand for grass
- Carrying capacity = how much grass do I have
- Match the stocking rate to the carrying capacity

Stocking Density

- Stock density is about MOUTHS, not pounds
- High stock density improves uniformity of grazing
  - Want the highest stock density possible
- Can be increased by increasing the number of animals in a herd or the number of paddocks per herd

Number of Paddocks per herd

- The easiest way to increase stock density is to combine herds
  - Or increase the number of paddocks per herd

- (1 cow x 100 days)/ 1 acre
- Stocking Rate = 100 Cow Days/Acre
- Stock Density = 1 Cow/Acre

- (100 cows x 1 day)/ 1 acre
- Stocking rate = 100 Cow Days/Acre
- Stock density = 100 Cows/Acre

Rest

How many paddocks do you need to get a 60 day rest period?

- Days in a paddock = (Rest period) / (# of pastures resting)
- Need 8-10 paddocks to stop overgrazing

Short graze periods improve animal performance

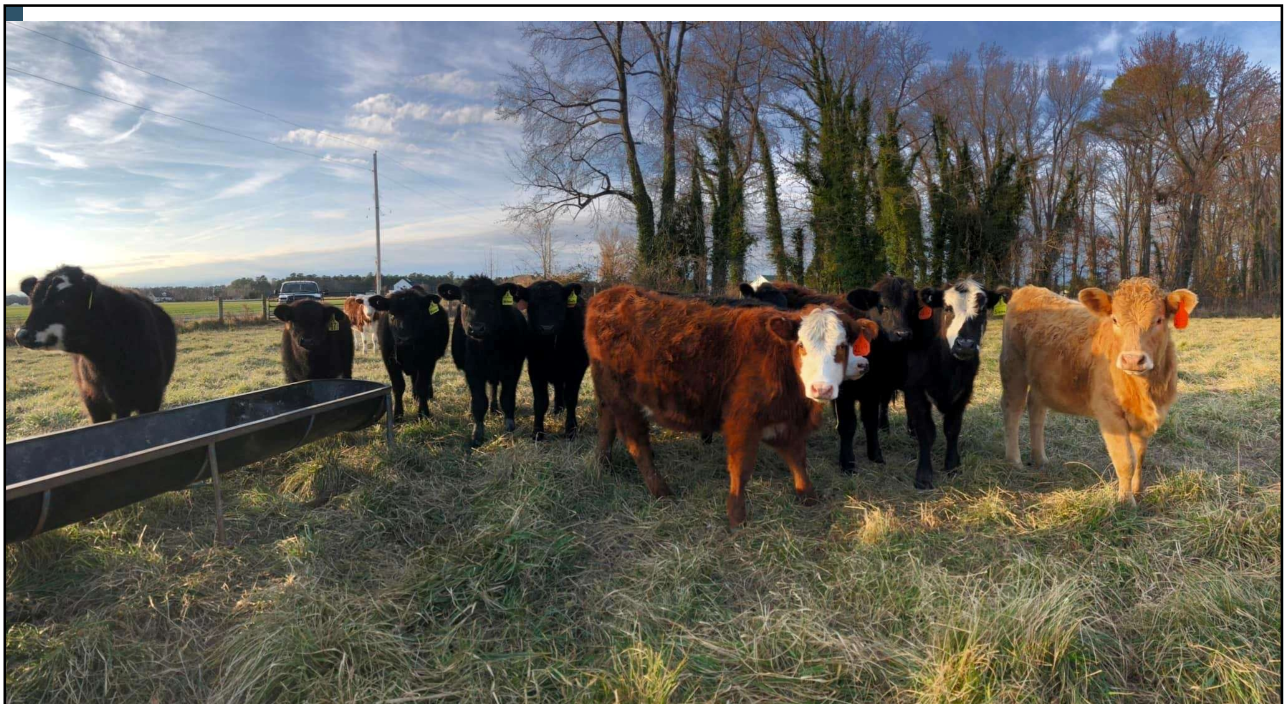
- Avoids second biting
- Good animal performance usually requires at least 14-16 paddocks per herd
- For rapid improvement, 25+ paddocks/herd are needed

Overgrazing vs severe grazing

- Severe grazing is grazing a plant down short
  - Drastically reduces the rate of recovery
- Overgrazing is grazing a plant before the roots have recovered from the previous grazing
  - Stay too long or come back too soon
- Overgrazing is a function of time

Animal Impact/Herd effect

- NOT related to stock density
- Concentrated, excited animal impact
- A factor of HOOVES

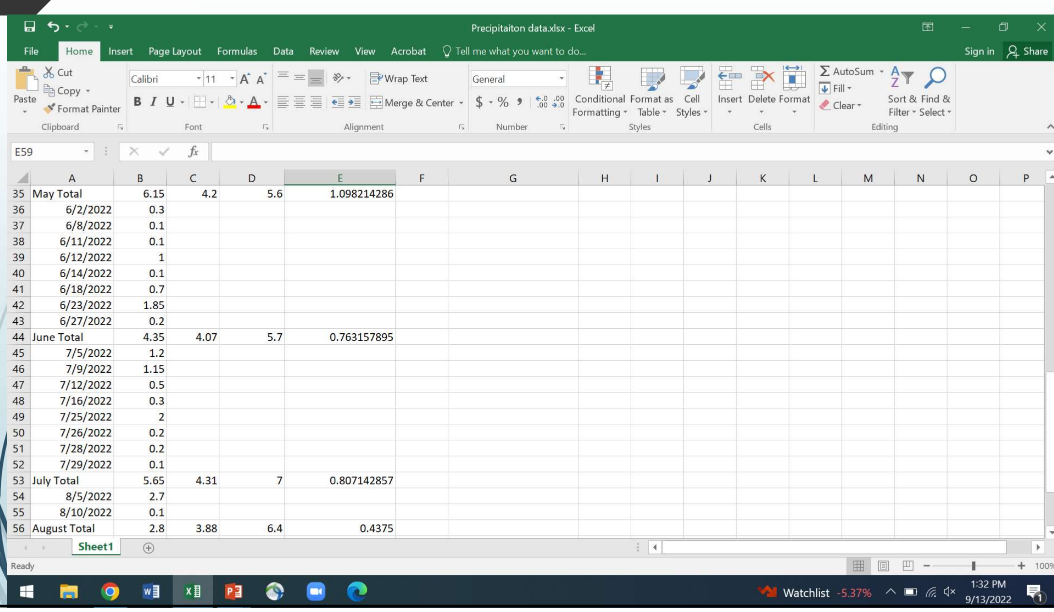


Build and ration a "feed bank" to reduce or eliminate the need for hay

- Stockpile forage
- Strip graze for high utilization

Pasture Layout

Rainfall tracking



	A	B	C	D	E
35	May Total	6.15	4.2	5.6	1.098214286
36	6/2/2022	0.3			
37	6/8/2022	0.1			
38	6/11/2022	0.1			
39	6/12/2022	1			
40	6/14/2022	0.1			
41	6/18/2022	0.7			
42	6/23/2022	1.85			
43	6/27/2022	0.2			
44	June Total	4.35	4.07	5.7	0.763157895
45	7/5/2022	1.2			
46	7/9/2022	1.15			
47	7/12/2022	0.5			
48	7/16/2022	0.3			
49	7/25/2022	2			
50	7/26/2022	0.2			
51	7/28/2022	0.2			
52	7/29/2022	0.1			
53	July Total	5.65	4.31	7	0.807142857
54	8/5/2022	2.7			
55	8/10/2022	0.1			
56	August Total	2.8	3.88	6.4	0.4375

Questions/Discussion

Northeast SARE
Sustainable Agriculture Research & Education

Number and Size of Paddocks in a Grazing System

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Two questions frequently asked by livestock producers developing a rotational grazing system is "how many paddocks do I need?" and "how large should they be?" The answers to these questions depend on the farmer's goals, the current level of forage production, the number and size of animals in the grazing herd, the nutritional needs of the animals, and what other feeds the animals will be given while on pasture.

The number of paddocks in a grazing system determines the flexibility the manager has in controlling the timing and intensity of livestock grazing. When grazing is managed carefully, increasing the number of paddocks can increase the available forage yield per acre and animal production per acre. However, this increase is at a diminishing rate as paddock numbers increase (Figure 1).

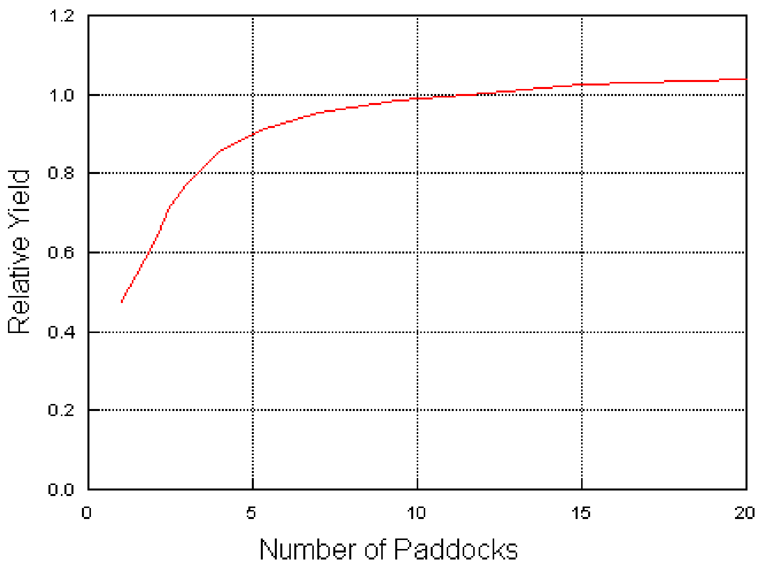

Figure 1. As the number of paddocks in a grazing system increases, pasture yield increases at a decreasing rate.

The optimum number of paddocks depends on the producer's goals, the class of livestock being grazed, and the local market and production economics. A greater number of paddocks is justified for lactating dairy cattle than beef cattle. Usually you can justify more subdivisions for stocker cattle than for a cow-calf herd. The number of paddocks in a grazing system depends on the regrowth or "rest" interval provided the pasture and the number of days the livestock are allowed to stay on the paddock. The total number of paddocks needed in the grazing system should be based on the longest regrowth interval and grazing-stay planned. This usually occurs in late summer.

The regrowth interval needed for optimum production depends on the forage species and the time of year. In the spring, grass-clover pastures need about 21 days of regrowth. This increases to 42 days in midsummer. Birdsfoot trefoil-timothy and alfalfa-smooth bromegrass pastures should have 35-42 days regrowth, depending on weather conditions.

Pastures should be grazed to the desired level using 3-7 day grazing-stay to prevent grazing of plant regrowth. A 3-day stay largely prevents regrowth grazing and may increase pasture production. The 3-day stay should be considered where economics justify the increased fencing and management input. A 7-day stay is often used by beef producers as a compromise and to simplify management. It also works well with and off-farm job that requires most management to be done on weekends. When grazing stays extend beyond 10 to 14 days, approximately half the pasture will be overgrazed and half undergrazed, resulting in poor forage utilization and regrowth.

For dairy cattle, the grazing-stay (time on a paddock) should be decreased to meet the animal’s nutritional needs. As a pasture is grazed, forage intake and nutritive quality decrease. For dairy cattle, this results in lower milk production after 3-days on a 7-day rotational system. One-day grazing stays are used by dairy producers first trying intensive rotational grazing. Many managers then go to a 12-hour stay since this provides more uniform nutrition from the pasture and requires little extra labor when using temporary fencing within permanent paddocks and the cattle need to be brought in every 12-hours for milking anyway.

The number of paddocks needed in a grazing system is equal to the number of days that a paddock will be rested, divided by the number of days it will be grazed, plus one paddock for the animals to be grazing while the other paddocks are resting. This is written as the equation:

Number of paddocks = (days rested/days grazed) + 1

Here is an example a livestock herd grazes paddocks for a 2-day stay and the pastures require a 42 day rest interval.

Number of paddocks needed = (42/2) + 1 = 21 + 1 = 22

Paddock size is determined by the available forage mass per acre before grazing and the forage requirement of the herd during the grazing-stay. Available forage dry matter (DM) per acre varies. A thick, well-managed, orchardgrass-white clover stand can provide 1500-1750 lbs. DM/acre available forage above a 2-to 3-inch stubble. Average grass-clover stands frequently provide 1000-2000 lbs. DM/acre of grazable forage in each grazing period.

Most livestock consume about 2.5% of their body weight in pasture DM daily. Dairy cattle require more feed, which is often provided as supplemental feed in the barn.

A good estimate of paddock size in acres is made by multiplying the pounds of pasture DM eaten per head per day (DM/head/day), times the number of head in the herd, times the days on the paddock, divided by the pounds of grazable forage DM available per acre (DM/acre). In equation form this is:

Paddock size acres = (DM/head/day x head x days) x DM/acre

The paddock size needed for a herd of 50, 1350 lb cows, consuming pasture at 34 lbs. DM/head/day (0.025 x 1350), grazing a pasture yielding 1250 lb grazable forage DM/a for a 2-day stay would be:

Paddock acres = (34 lbs. DH/head/day x 50 head x 2 days)/1250 DM/acre = 2.72 acres

Estimates made using these equations will provide realistic paddock numbers and size. When potential pasture production is greater than the animals' need the extra forage can be harvested from some paddocks for stored feed or for sale. Experience, common sense, and proper pasture and livestock management will allow livestock producers to make the most from their grazing system.

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Estimating Hay and Pasture Forage Yields

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UNIVERSITY OF MARYLAND EXTENSION

Why Evaluate Forage Yield?

- Estimating forage inventory allows for budgeting of feed
- Allows for determination of appropriate stocking rates
- Can be used to evaluate different pasture grasses or track productivity over time
- Necessary for determining yield goals and fertilizer needs

Method 1: Clip and Weigh

This method involves hand clipping multiple small forage samples collected throughout the field, and drying and weighing the collected sample to calculate the amount of available forage on a dry matter basis.

Tools required: clippers, sampling square, paper bag, scale, microwave (or forage dryer)
Pros: most accurate method
Cons: very time consuming, most labor intensive

Procedure:

1. Walk through the field in a random pattern.
2. At a random location, collect a hand clipped forage sample by clipping the available forage within the sampling square down to a height of 3-4 inches.
3. Collect all clippings in the paper bag (or several if needed).
4. Repeat steps 2-3 throughout the entire field.
5. Weigh the bag(s) to get the total wet weight of the collected forage.

   Total wet weight = ____________
6. Thoroughly mix and take a subsample (about 1 pound) from the collected forage.
7. Weight the subsample to get the subsample wet weight.

   Subsample wet weight = ____________
8. Dry the subsample. To do so, place the forage in a microwave-safe dish. Place the dish in a microwave oven along with a cup of water (helps to reduce the risk of burning the forage). Heat the subsample on high for two minutes and weigh the forage, then place

the subsample back in the microwave, heat it for an additional 30 seconds, and weigh the subsample again. If the before and after weights differ, heat the sample for an additional 30 seconds and reweigh the subsample. Continue this process until the weight does not change.

9. Weigh the final dried subsample to get the subsample dry weight.
   Subsample wet weight = ____________
10. Calculate the percent dry matter in the subsample:
    Subsample % DM = (subsample dry weight/subsample wet weight) x 100
11. Use the percent dry matter to calculate the dry matter of the total sample:
    Total DM weight = total wet weight x % DM
12. Calculate the acreage of the clipped area:
    Acres = square feet of sampling square x number of squares clipped / 43,560
13. Calculate the pounds of dry matter per acre:
    Dry matter per acre = total dry matter / acreage of clipped area

Clip and Weigh Calculations:

Total wet weight: __________ lbs

Subsample wet weight: __________ lbs

Subsample dry weight: __________ lbs

Subsample % DM = (__________/__________) x 100 = __________ % DM

Total DM weight = __________ lbs x __________ % DM = __________ lbs of DM

Clipped area acreage = _________ ft^2 x _________ squares / 43,560 = _________ acres

DM lbs/acre = __________ lbs of DM x __________ acres = __________ DM lbs/acre

Method 2: Rising/Falling Plate Meter

This method estimates forage yield based on plant height and stand density. It involves walking through the field and recording plate meter values at numerous random locations to get an average for the entire field. Estimation equations can then be used to calculate the amount of available forage. A plate meter lies on the surface of the pasture, compressing the pasture down to a level that supports the weight of the plate. There are options for DIY plate meters you can make yourself or commercially available plate meters you can purchase (Figures 1-3).

Tools required: rising/falling plate meter
Pros: less time consuming, fairly precise
Cons: can be more expensive if purchased

Procedure:

1. Walk through the field in a random pattern.
2. At a random location, place the plate meter gently on the forage until it supports the weight of the plate.
3. Measure and record the height at the top of the plate meter.
4. Take note of whether the pasture stand density is thin, average, or thick.
5. Repeat steps 2-4 throughout the entire field. A total of 20-30 points is recommended to get a good representative sample.
6. Calculate the average plate meter value and average stand density for the pasture.
7. This average plate meter value and density are correlated with the forage height and can be converted to yield using a calibration equation. A table with calibration data (based on cool-season grass-legume pastures in the Mid-Atlantic) is shown below.

Fig. 1. Use a ruler to measure pasture height by placing the end of the ruler on the ground, hold the ruler vertical, and estimate the average height of the top leaves in the pasture.	**Fig. 2.** Use a falling plate meter to measure pasture height by placing the ruler through the center hole in the plate, place the ruler's end on the ground, lower the falling plate meter onto the pasture, measure the plate's height above the ground.	**Fig. 3.** Use the rising plate meter to measure pasture height by holding the shaft vertically, place the plate on the pasture, push tip down to the ground, making the plate rise up the shaft moving the counter to measure the plate height above the ground.
		

Source: Rayburn, WVU

Table 1. General calibrations for pasture forage density and forage mass at different mean pasture heights as measured with a ruler, a falling plate meter, and a rising plate meter.

Measurement Method			Pasture Density		
			Thin	Average	Thick
Ruler Ht. inches	Falling plate meter Ht. inches	Farm Tracker rising plate meter Ht. inches	Forage Mass lbs. DM/acre		
2	1.0	0.8	350	680	1020
3	1.7	1.3	580	1070	1570
4	2.3	1.8	810	1440	2070
5	3.0	2.4	1050	1770	2500
6	3.6	2.9	1300	2080	2870
7	4.2	3.4	1550	2370	3190
8	4.9	3.9	1810	2620	3440
9	5.5	4.4	2080	2860	3640
10	6.2	4.9	2350	3060	3770
11	6.8	5.4	2630	3240	3840
12	7.4	5.9	2920	3390	3860

Source: Rayburn, WVU

Method 3: Grazing Stick

Like the plate meter, this method also estimates forage yield based on plant height and stand density. It involves walking through the field and recording both pasture height and density measurements at numerous random locations to get an average for the entire field. These numbers can then be used to calculate an estimation of the amount of available forage.

Tools required: grazing stick
Pros: fast, simple, cheap/free
Cons: less precise, may be more subjective

Procedure:

1. Walk through the field in a random pattern.
2. At a random location, use the ruler on the side of the grazing stick to measure and record the forage height. If you spread your hand and lower it onto the plant canopy, height should be measured at the point where very modest resistance from the plant canopy is felt on your hand.

3. At the same locations, use the grid with dots on the side of the grazing stick to measure and record forage density. Slide the stick sideways into the standing forage. With the stick flat on the ground underneath the forage canopy, look straight down and count the number of dots you can readily see. Based on the number of dots visible, the density will fall into one of three categories: less than 75%, 75-90%, or more than 90%.

4. Repeat steps 2-3 throughout the entire field. A total of 20-30 points is recommended to get a good representative sample.
5. Calculate the average height for the whole field and subtract 3-4 inches to account for remaining residue or stubble and get the height available to be grazed or harvested.
6. Calculate the average forage density for the field. Based on this average forage density and the species present in the pasture, use the information on the pasture stick to determine the number of pounds of available forage per acre per inch of height.
7. Multiply the pounds per acre-inch by the average available forage height to find the total amount of available forage in pounds per acre.

Grazing Stick Calculations:

Average forage height: __________ inches

Average height of standing forage – residual grazing height = available forage for grazing		

Average forage density: __________ dots = ______________ % cover

Estimated pounds of dry matter per acre-inch: __________ lbs/acre-inch

** based off table on pasture stick*

Inches of forage available for grazing x estimated lbs/acre-inch = available lb DM/acre		

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Using a Grazing Stick for Pasture Management

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Good management of livestock feeding enterprises requires an understanding of feed inventories and their use. Gathering this information is straightforward in grain-based feeding systems because bushels of stored grain are easily measured, and the amount fed per day is determined by the ration and the number of animals.

In pasture systems, however, keeping a forage inventory is more difficult. Feed may be allocated for more than one day, and feed quantity and quality are influenced by weather, fertility, stand density, and season. Not all of the feed available is consumed, and the plants continue to grow after they are grazed. Variation in feed quality and animal production status (pregnant, dry, lactating, growing, etc.) may also influence feed consumption.

This publication is intended to help producers meet animal forage needs in a rotational grazing system by mastering the use of a grazing stick to estimate pasture yield and pasture allocation.

Grazing sticks are useful for making immediate pasture management decisions, but good records of pasture yield, grazing days, and other data will provide a means to evaluate past efforts. Grazing sticks look like a simple measuring device, but are really a measurement system. They include a ruler for measurement, grazing guidelines, and conversion formulas for making immediate pasture management decisions. Grazing sticks are handy tools that simplify measuring pasture yield, allocating pasture to animals, and tracking productivity changes. These tasks are all critical aspects of good pasture management.

Grazing sticks vary somewhat from state to state. The Kentucky model consists of the following, shown on the stick itself:

- A ruler to measure forage height
- A quick guide to start and stop grazing on a paddock
- A table to convert stand density to dry matter per acre-inch
- Formulas for pasture allocation and management decisions
- General guidelines and planning information

Using the Grazing Stick

Yield Estimation

Keep in mind the estimate is only as good as the sample. If the forage stand and the topography are uniform, a minimum of one sample per acre is recommended. Take more measurements for fields with variable soils, topography, or forage stands.

Figure 1. Ruler used to measure height.

Step 1—Use the ruler to measure forage height (Figure 1). With most forages, plant height taller than 18-24 inches is really better suited to hay than to grazing. This is particularly true with endophyte-infected tall fescue, because toxins increase with stem growth and seed head development. See *Sampling Tall Fescue Endophyte in Pasture or Hay Stands* (PPA-30) for more information on dealing with infected tall fescue.

Height is not a measure, but rather an average, of the tallest plants. Spread your hand and lower it onto the canopy. The average height is measured at the point where you feel very modest resistance from the plant canopy. In Figure 1, the height is 7 inches. Record the height for each sample location in the pasture and then calculate the average height for the pasture.

Step 2—Stand density is the amount of the ground surface covered with standing forage. Your goal is to place the pasture into one of three density categories (less than 75%, 75 to 90%, or more than 90%).

Visually estimate stand density by looking directly down at each location where you have just measured canopy height. Do not include ground residue, only plant material tall enough for the livestock to consume. Stand density measurements using the grazing stick are most accurate when canopy height is approximately 8 inches.

Record the density reading for each location, then calculate the average stand density for the pasture. The density yield table (Table 1) can now be used to estimate forage yield per acre-inch. The table is more accurate with denser stands.

Step 3—Determine the dry matter (DM) yield per acre-inch using the density measured in Step 2. For example, if you are measuring a tall fescue pasture and you estimate that the available forage covers 85% of the ground area, this pasture would be assigned to the middle density category of 75 to 90% cover. According to Table 1, this density rating would be between 150 and 200 lb of DM per acre-inch. Based on your assessment of the stand, assign a yield. The thicker the stand, the closer the yield will be to the upper end of the range. Since 85% is in the upper end of this density category, 200 lb of DM per acre-inch would be a good estimate. If the average stand height is 8 inches and you want to maintain 3 inches of stubble after grazing, available forage equals:

5 inches x 200 lb/acre-inch = 1,000 lb DM/acre.

Step 4a—Calibration (quick estimate): A periodic check of your measurements can help you be consistent in using the grazing stick. Harvest 1 square foot of forage (cut at soil level), weigh it in grams, and multiply it by 20. This calculation will give an estimate of lb per acre assuming the forage is 20% DM. While this method is useful for a quick check, the DM content of forage does vary throughout the year, so the yield estimate will be more accurate if the sample is actually dried.

Step 4b—Calibration (better estimate):

1. Harvest 1 square foot of forage (cut at soil level) and chop the forage into 1- to 2-inch lengths.
2. Weigh the forage (in grams) then place it on a microwave-safe dish. Place the dish in a microwave oven along with a cup of water, which helps reduce the risk of burning the forage.
3. Heat on high for two minutes.
4. Weigh the forage.
5. If the forage is not dry, place it back in the oven and heat it for 30 seconds more.
6. Repeat steps D and E until the weight does not change. If the forage is charred, use the last weight.
7. Multiply the dry weight in grams by 100 for an estimate of dry matter yield in lb per acre.

Table 1. Estimated dry matter yield per acre inch based on density and forage type.

	Density		
	<75%	75-90%	>90%
Forage	Dry Matter Yield (lb)		
Tall fescue or orchardgrass	50-150	150-200	200-300
KY Bluegrass	50-100	100-175	175-250
Cool-season grass (clover)	50-125	125-200	200-275
Bermudagrass	100-200	200-300	300-400
Alfalfa	75-150	150-225	225-300
Red clover	75-125	125-175	175-250

Allocate Forage

Your pasture system will determine how you apportion forage for your animals. If you are using temporary electric fencing and allocating acreage to feed your animals for a specific number of days, you will need to calculate the acres needed per day. If you have a slow rotation with modest-sized paddocks, you will have to determine how many days a particular paddock will carry your herd. If you can vary animal numbers to fully utilize your available pasture, you will have to determine how many animals are required. Each situation will require you to estimate yield and to make the appropriate allocation. In addition to forage yield, the formulas for calculating pasture allocation require values for percent utilization (Table 2), animal weights, and animal intake (Table 3).

Table 2. Percent utilization of available forage based on grazing system.

System	Utilization
Continuous	30-40%
Slow rotation (3-4 paddocks)	40-55%
Fast rotation (8+ paddocks)	55-70%

Source: The Kentucky Grazing Stick.

Table 3. Forage intake guidelines.

Livestock Class	Dry Matter Intake as Percent of Body Weight
Dry beef cow	2
Lactating beef cow	3-4
Lactating dairy cow	2.5-5*
Stockers	2.5-3.5
Horses	2.5-3
Sheep & Goats	3.5-4

*May include grain.

Utilization is defined as the percent of the available forage that animals consume. Utilization rates vary with the intensity of the grazing system (Table 2).

Animals will only use 30-40% of the forage on a continuously grazed pasture because they have excess forage and graze selectively. The forage they do not eat may become mature and unpalatable. In addition, much of the available forage becomes waste because it is trampled or fouled with dung or urine.

With pasture rotation, the grazing period is shortened, animals cannot be as selective, and less forage is wasted (Table 2). With a slow rotation (three to four paddocks, animals moved every seven to 10 days), the utilization increases to 40-55%. A faster rotation will increase utilization to 55-70%. It is possible to achieve higher utilization (70-80%) with intensive rotational systems (animals moved once or twice a day).

Livestock species, class, and physiological condition all have profound effects on intake (Table 3). Forage intake may also be influenced by the stage of plant growth. Mature plants are a low-quality feed because they have high fiber content. Fiber digests slowly and limits the amount an animal can consume. See American Farm Bureau publication *Understanding Forage Quality* (pub. no. 1-01) for more detailed information. Lactating dairy cows need a high level of nutrition to maintain high levels of milk production and, as indicated in Table 3, some supplementation with grain may be necessary to provide sufficient intake for these animals.

Pasture Allocation Examples Using Formulas from the Grazing Stick

Calculate: The paddock size needed to feed a set number of animals.

Example 1: 100 dry cows, average weight 1,350 lb.

$$\text{Acres required/paddock} = \frac{(\text{weight}) \times (\text{intake in \% body weight}) \times (\text{animal \#}) \times (\text{days/paddock})}{(\text{available DM/acre}) \times (\text{\% utilization})}$$

Step 1—Animals will be moved every three to five days in an eight-paddock system, so utilization is estimated to be 60% (Table 2).

Step 2—Set intake—because they are dry cows, use 2% (Table 3).

$$\frac{(1{,}350 \text{ lb/cow}) \times (0.02\text{/day}) \times (100 \text{ cows}) \times (4 \text{ days})}{(1{,}000 \text{ lb/acre}) \times (.60)}$$

$= 18$ acres

Calculate: The number of animals needed to utilize the available forage.

Example 2: The paddock size is 20 acres and the grazing period is 4 days.

$$\text{\# of animals required to graze a paddock} = \frac{(\text{DM/acre}) \times (\text{acres}) \times (\text{\% utilization})}{(\text{animal weight}) \times (\text{intake in \% body weight}) \times (\text{days})}$$

$$\frac{(1{,}000 \text{ lb/acre}) \times (20 \text{ acres}) \times (.60)}{(1{,}350 \text{ lb}) \times (0.02\text{/day}) \times (4 \text{ days})}$$

= 111 cows would be needed to graze these pastures down in 4 days.

Calculate: The number of days a paddock will last.

Example 3: A herd of 100 cows on a fast rotation.

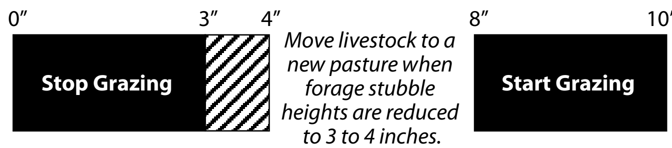
$$\text{Days of grazing per paddock} = \frac{(\text{DM/acre}) \times (\text{acres}) \times (\text{\% utilization})}{(\text{animal weight}) \times (\text{intake in \% body weight}) \times (\text{\# animals})}$$

$$\frac{1{,}000 \text{ lb/acre} \times 20 \text{ acres} \times .60}{1{,}350 \text{ lb} \times 0.02\text{/day} \times 100 \text{ cows}}$$

$= 4.4$ days

The grazing stick also has a quick guide (Figure 2). If you carry the stick with you whenever you check animals or move fences, you can quickly assess pasture regrowth and readiness for grazing. The suggested starting height for grazing cool-season grasses is 8 to 10 inches, which ensures that forage is in a high-quality vegetative stage. The stop-grazing limit applies to grass or grass-legume pastures. The 3- to 4-inch stubble height ensures that some leaf tissue is available for grass regrowth. Removal of basal leaves will slow grass regrowth and limit yield. If pastures are growing quickly in the spring, you may need to harvest or clip them to keep them productive and in high-quality condition.

Figure 2. Quick grazing guide.



The guidelines for grazing vary according to the plant species (Table 4). For example, grazing is normally delayed until bud stage for alfalfa so that the plants can restore root reserves that were used in regrowth. Consistently grazing forages before the indicated height or stage may thin the stand. Overgrazing so that too little stubble remains after grazing may limit pasture yield because the plants will not have enough leaf tissue for photosynthesis and rapid growth. Rest periods and forage removal must be carefully balanced to keep pastures productive. One of the best ways to achieve this balance is by frequently observing pastures and the amount of pasture regrowth. In spring, pasture growth is often too rapid for optimum grazing, so rotations may need to be accelerated to maintain good pasture quality. In summer, cool-season plants grow more slowly, and the rotations may need to be slowed to allow full recovery from grazing. When planning grazing systems, you can calculate the number of paddocks necessary to provide a desired rest period.

$$\text{Number of paddocks} = \frac{(\text{days of rest})}{(\text{days of grazing})} + 1$$

Table 4. Guidelines for Optimum Grazing Height (in inches).

Forage	At Beginning of Grazing	At End of Grazing
Cool-season grasses and legumes other than alfalfa	8-10	3-4
Alfalfa	Bud stage	2-3
Annual warm-season grasses	20-24	8-10
Native warm-season grasses	18-22	8-10
Bermudagrass	6-8	1-2

Good Record Keeping

You'll find the grazing stick a handy tool, but keep in mind that it provides only an estimate of pasture yield. You can improve your grazing system with good records of pasture yield, grazing days, and other data because they allow you to evaluate past efforts. If you keep good records and compare yield estimates with data from actual grazing days, you will be able to more closely calculate the actual yield for your farm and your conditions.

Grain producers determine the number of inputs to use based on the yield they will gain from each one. Because inputs and the resulting yield are easily measured, grain production systems can be quickly refined and improved. Good pasture records are slightly more difficult to collect, but they can also contribute to rapid improvement of pasture systems. One objective of pasture improvement is to increase yield, but changes in pasture management may also target herbage quality, yield distribution, or persistence. Pasture improvement may result in improved gains, increased carrying capacity, or reduced need for supplementation during summer months. Records help a manager place a value on improvements and make decisions on where to spend limited resources to maximize the benefits. These improvements are not necessarily obvious unless producers keep good records and study them.

More specific information about grazing, pasture management, and forage species is available in UK Cooperative Extension publications such as *Rotational Grazing* (ID-143). A list of recommended publications is included at the end of this document.

All your record information should be entered in a timely manner and regularly reviewed. It should include record year, paddock identification, paddock size, monthly rainfall, date and amounts of fertilizer, seed and pesticide inputs, and the most recent soil test data. In addition, each time a paddock is grazed, record the number and average size of animals, dates in and out, pasture height at the beginning and end of grazing, and yield estimate and stand density at the start of grazing.

Using Your Records for Planning

Records must be studied. Some people diligently keep records and file them at the end of the season. It will take some work to compile records into a form that you can use efficiently, but this effort is worthwhile. If you are going to keep records, commit yourself to using them.

Here are a few questions that might be answered by studying your pasture records:

- How much did legumes increase animal grazing days per acre during the summer?
- How much did fertilizer improve animal grazing days per acre?
- Which pastures and forages performed best in a dry year?
- How severe is the summer slump? Do you need to increase production during this period?
- Are your pastures improving or declining? Do you need to increase or decrease stock density to improve your pastures?
- Did your stockpile run out before spring growth began? How many more acres of stockpile do you need to support the herd? Can you fill gaps in forage production by grazing crop residues?
- Did your pasture management improvements result in reduced costs, increased carrying capacity, or better gains?

The following is a selection of the publications on forages and grazing available online at www.uky.edu/Ag/Forage/ForagePublications.htm or from your extension agent.

AGR-59—*Tall Fescue*

AGR-85—*Efficient Pasture Systems*

AGR-108—*Tall Fescue in Kentucky*

AGR-119—*Alternatives for Fungus Infected Tall Fescue*

AGR-162—*Stockpiling for Fall and Winter Pasture*

AGR-175—*Forage Identification and Use Guide*

ID-74—*Planning Fencing Systems for Intensive Grazing Management*

ID-97—*Grazing Alfalfa*

ID-143—*Rotational Grazing*

AE 2005-04—*The Economics of Renovating Pastures with Clover*

AE 2005-05—*The Economics of Using Improved Red Clover Varieties*

AE 2005-06—*The Economics of Pasture Fertilization*

PPA-30—*Sampling for the Tall Fescue Endophyte in Pasture or Hay Stands*

Tall Fescue Endophyte Concepts—Don Ball et al., 2003, Oregon Tall Fescue Commission, Spec. pub. No. 1-03

Understanding Forage Quality—Don Ball et al., 2001, American Farm Bureau pub. No. 1-01

Additional Useful References

Ball, D.M, C.S. Hoveland, and G.D. Lacefield. 2002. Southern Forages. 3rd ed., Potash and Phosphate Institute, Norcross, GA 30092.

Determining Forage Moisture Content Using a Microwave Oven

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Extension Service
West Virginia University

A Falling Plate Meter for Estimating Pasture Forage Mass

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Background

It is often helpful to have a reliable estimate of forage on offer to grazing livestock. Research has shown that there is a high correlation between forage height and dry matter yield. This correlation is improved when bulk height is determined by depressing the forage with a weighted plate. This weight plate technique referred to as a weighted disk meter, appears to improve the estimate of pasture yield. Different designs of weighted disk meters are called rising plate meters and falling plate meters depending on how measurements are taken. The weighted disk meter described here is a falling plate meter.

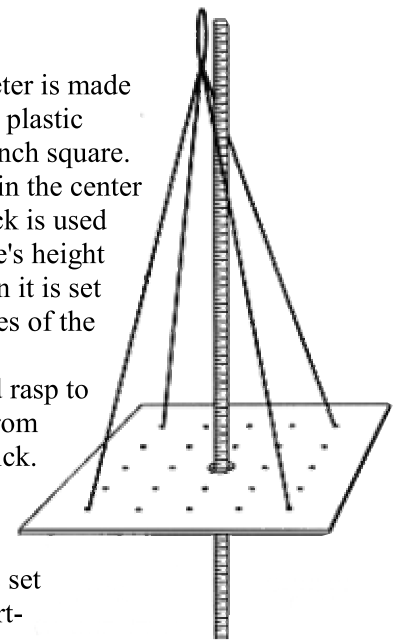
Weighted disk meters are generally made of sheet metal using an etched metal measuring rod. Researchers have used modifications of this design to establish the effect of size and area weight on the performance of these meters. Based on this research, an inexpensive weighted disk meter was made from acrylic plastic for use in conducting on-farm research and demonstration programs.

Material

The material needed for a practical pasture plate has to meet the following requirements: it must be readily available in standard stock across the region, it must be stable in weight per unit area when exposed to moisture in the air and on the forage, and it must be relatively inexpensive. Acrylic plastic sheeting meets all these requirements.

A square of acrylic plastic measuring 0.22 inches thick and 18 inches square was chosen. This thickness has a weight per area (1.47 lb./sq. ft.) that results in good prediction of dry matter yield and is inexpensive. The cost of the 18-inch plate was about $15 (2002). When used with a yardstick, this makes an inexpensive and serviceable falling plate meter for estimating forage yields.

Construction



The falling plate meter is made from 0.22-inch acrylic plastic sheeting cut in an 18-inch square. A 1.5-inch hole is cut in the center of the plate. A yardstick is used for measuring the plate's height above the ground when it is set on the sward. The edges of the center hole need to be smoothed with a wood rasp to prevent rough edges from catching on the yardstick.

In addition 24, 0.125-inch holes are drilled along five lines set at 3-inch intervals, starting 3 inches from the plate's edge. Holes are spaced at 3-inch intervals along these lines, again starting 3 inches from the edge. This results in 24 holes (the 25th hole being in the yardstick hole). These holes can be used for estimating ground covered in thin stands and in grazed stubble.

The yardstick should be connected to the plate so that the two can be carried as one unit. One way to do this is to tie a string through two or four of the small holes in the plate. Tie a loop at the top of the string, and hold the loop in the hand that is holding the yardstick. The user then places the tip of the yardstick on the ground and lowers the plate gently to the surface of the forage canopy. Click here for construction details.

Use

Use the plate meter by walking the pasture, selecting a location at random, and placing the plate gently on the forage until it supports the plate. Measure the height of the plate's top above the ground. Placing the plate on the forage is more satisfactory than dropping the plate from a standard height. We found that dropping the plate is not practical on hills or on windy days.

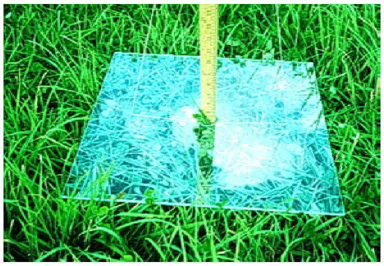


Figure 1. The plate meter and yardstick using a looped string so that the plate and yardstick can be held in one hand. (Click here for enlarged view).

To achieve a good estimate of the forage mass in a pasture, you must measure enough points. The reliability of the mean pasture height increases as the number of samples increases to 20 or 30, with a little improvement as the sample size increases to 50. Our recommendation is to take at least 30 bulk height measurements per pasture.

When selecting the sample location the user should be careful not to bias the average by choosing more productive areas over less productive areas. Sample to get a representative sample over the pasture. When the general area is reached, the sample point should be taken at random. If the sample point has old seed heads or large weeds, which will bias the plate height, move the plate to one side to miss the obstruction. When used in well-managed, rotationally-grazed or clipped pastures this is not a major problem.

Calibration

Calibration equations for the pasture plate may vary due to species, season, and location. For calibration we use a square wire frame that just fits over the pasture plate. The frame is set over the sample site and the plate removed. The forage is then separated so that the frame lies on the ground. The forage is cut as close to ground level as possible with battery-powered lawn edgers. The forage is weighed wet in the field using lightweight spring scales and composited for dry matter determination. Regression equations are calculated from the measured bulk height and dry matter yield using a scientific calculator.

An alternative to calibration is to calculate the forage density at each sample point by dividing dry forage mass (lb/a) by the plate height of the sample. Density is then lbs dry matter/acre/inch plate Ht. Then average these densities for all the paired clipped samplings.

Testing

The pasture plate has been used extensively in pasture sampling from 1986 through 2003 on cool- season grass-legume pastures managed under intensive rotational grazing. These pastures include orchard grass, timothy, quackgrass, bluegrass, ryegrass, white clover, and red clover stands. An average calibration for estimating dry matter yield (DMY) from pasture plate height was found to be:

DMY lb./a = 432 Plate Height (inches)

The fact sheet “Estimating Pasture Forage Mass from Pasture Height” gives more details on general calibrations for use with the falling plate meter, a commercial rising plate meter and ruler measurements of pasture height.

This falling plate meter has been used by farmers over the Northeast as part of the Northeast Dairy Farm Forage Demonstration (a NESARE Project) and as part of other collaborative regional research projects. This plate is as reliable as the more sophisticated metal weight disks meters or expensive electronic probes and provides a practical, low-cost means of extending research recommendations to farmers.

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3. Michalk, D.L. and P.K. Herbert. 1977. *Assessment of four techniques for estimating yield on dryland pastures*. Agronomy Journal. 69:864-868.
4. Varth, E.W. and A.G. Matches. 1977. *Use of a weighted-disk measure as an aid in sampling the herbage yield on tall fescue pastures grazed by cattle*. Agronomy Journal. 69:888-890.

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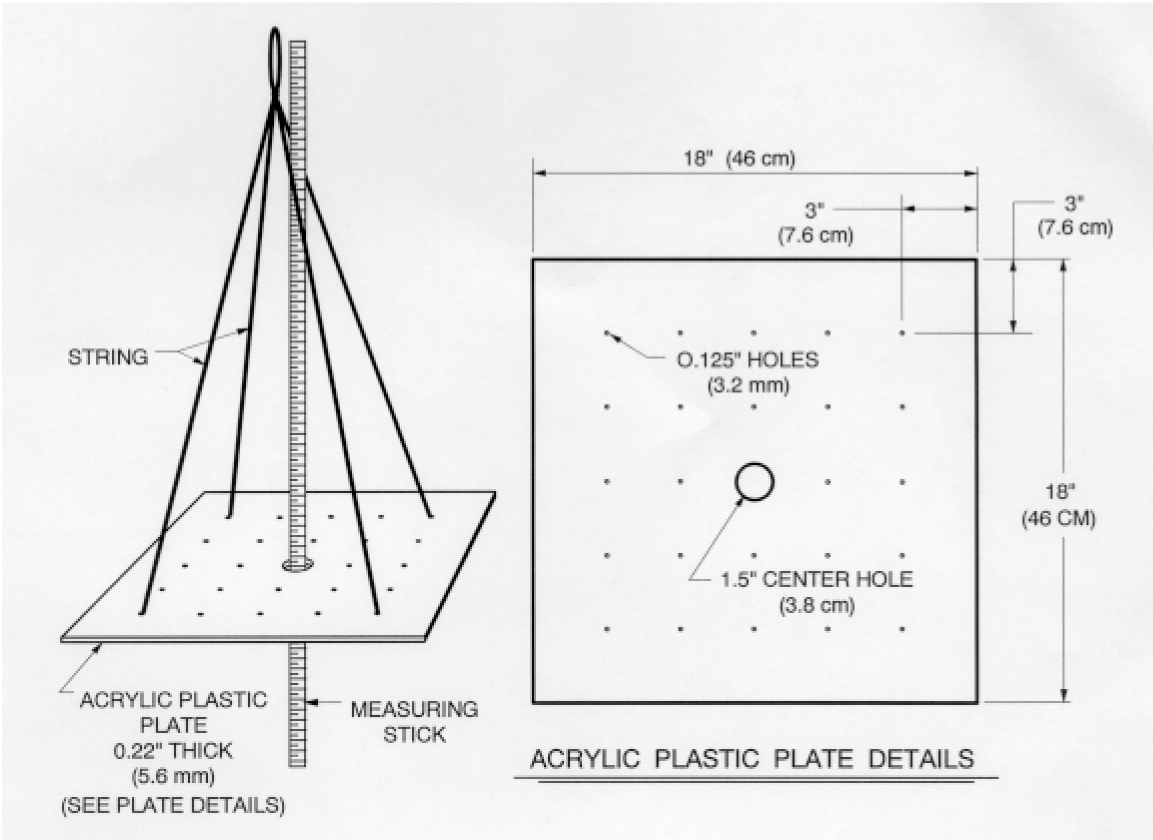
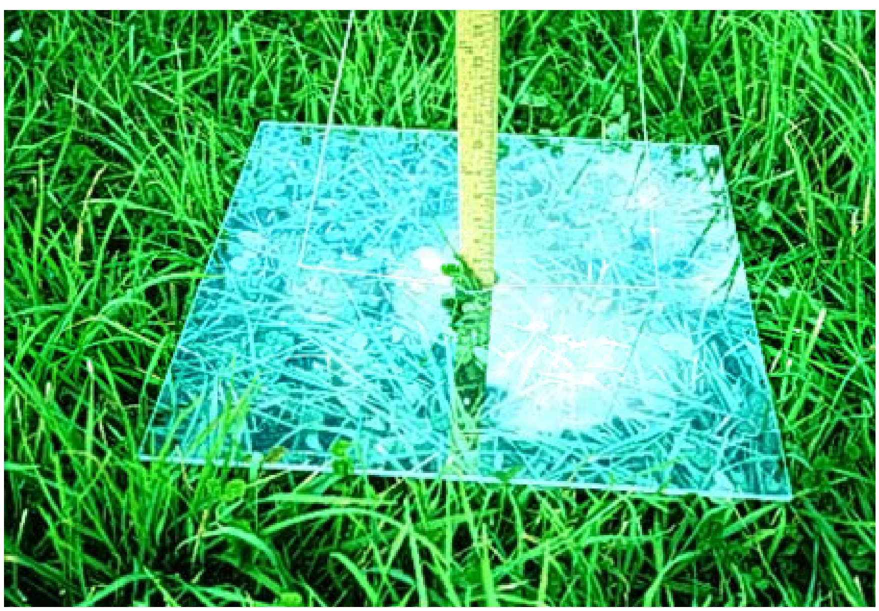

STRING
ACRYLIC PLASTIC PLATE 0.22" THICK (5.6 mm) (SEE PLATE DETAILS)
MEASURING STICK
18" (46 cm)
3" (7.6 cm)
3" (7.6 cm)
O.125" HOLES (3.2 mm)
18" (46 CM)
1.5" CENTER HOLE (3.8 cm)
ACRYLIC PLASTIC PLATE DETAILS



Grazing Arithmetic Worksheet

The basic calculations of grazing arithmetic revolve around estimating forage supply, grazing efficiency, and daily livestock intake requirements.

FORAGE SUPPLY

Measuring and Estimating Forage Supply

1. Identify the dominant forage (or forage mixture) in the stand
2. Measure the forage height in inches (remember to subtract residual grazing height)
3. Estimate lbs/ac-inch using the table below (also found on a grazing stick)
4. Repeat 15-30 times across the paddock
5. Average your results

Estimated dry matter yield per acre inch based on stand density and forage type			
	Density by Ground Cover		
	< 75%	**75 – 90%**	**> 90%**
Forage Type	**Dry Matter Yield (lb/ac-inch)**		
Orchardgrass + legume	100 – 200	200 – 250	250 – 300
Tall fescue + legume	150 – 200	200 – 250	250 – 350
KY Bluegrass	50 – 100	100 – 175	175 – 250
Stockpile fescue + N	200 – 250	250 – 350	350 – 450
Bermudagrass	100 – 200	200 – 300	300 – 400
Mixed pasture	150 – 225	225 – 300	300 – 350

STANDING BIOMASS

Use these calculation steps to determine the total amount of biomass, or available forage, in the pasture.

Average height of standing forage –	target residual grazing height =	available forage for grazing (inches)

Inches of forage available for grazing X	estimated lbs/ac-inch =	available forage DM per acre

HARVEST EFFICIENCY

Livestock are not 100% efficient at grazing forage evenly, and utilization will vary by grazing system. To factor in an estimated harvest efficiency in your grazing planning use a percent utilization from the table below.

Percent Utilization of Available Forage	
Grazing System	**Utilization**
Continuous	30 – 40%
Slow rotation (3-4 paddocks)	40 – 55%
Fast rotation (8+ paddocks)	55 – 70%
Strip grazing	75%

Available forage DM per acre X	harvest efficiency =	estimated available forage grazed by livestock

LIVESTOCK DEMAND

To calculate livestock demand you must consider:

1. The type and number of animals
2. The average animal weight
3. Daily intake rate as a % of body weight

Demand = animal weight X # of animals X DMI (% BW)

Dry Matter Intake Guidelines	
Animal Class	**DMI as % BW**
Dry cow	2%
Lactating beef cow	2.5 to 3%
Lactating dairy cow	3 to 5%
Stocker calf	2.5 to 3.5%
Sheep and goats	3.5 to 4%
Horse	2 to 3%

Average animal weight (lbs) X	# of animals X	daily intake rate (% BW) =	daily demand (lbs DM)

PASTURE ALLOCATION

Altogether, we have determined a livestock demand of about __________ lbs DM per day and a forage supply of __________ lbs DM.

From there, we can determine pasture allocation in one of two ways:

1. The estimated grazing period in a given paddock (if paddock size is already fixed)
2. The size we need to make a paddock to graze a certain number/type of livestock for a certain time period (if paddock size is not yet fixed)

ESTIMATING GRAZING PERIOD

How many days will this herd of livestock be able to graze in this pre-determined paddock?

Acreage in paddock X	available forage DM per acre =	available forage DM in paddock

Forage supply (lbs) /	daily livestock demand (lbs) =	estimated grazing period for this paddock (days)

Our grazing period for this pre-determined paddock is estimated at __________ days.

ESTIMATING PASTURE ALLOCATION

How big do we need to make our paddock to support this herd of livestock for ______ days?

Daily livestock demand (lbs) /	forage supply (lbs) =	acres needed to support 1 day of grazing

Acres needed to support 1 day of grazing X	# of days =	total acreage needed

We need a total of ________ acres to support this herd for ________ grazing day(s).