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Using a Rising Plate Meter to Determine Paddock Size for Rotational Grazing

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Introduction

In rotational grazing, pastures are subdivided into paddocks that are grazed successively for relatively short intervals. Because animal intake and forage growth rates change over the grazing season, regular monitoring of pasture dry matter is needed so pasture availability doesn't limit intake. Pastures should be grazed just as they reach maturity, while their quality is still high, and enough stubble should be left after grazing to support rapid forage regrowth. Using a rising plate meter, the amount of forage dry matter in a pasture can be determined before grazing. Then by estimating the intake of the animals to be grazed, factoring in the length of time they will graze a paddock and the amount of stubble to be left after grazing, the optimal paddock size can be calculated. Employing this level of pasture management will maintain high forage quality and rapid regrowth, and support the greatest gain or milk production on pastures. This Extension bulletin will explain how a rising plate meter can be used to make quick and accurate pasture dry matter measurements.

The Rising Plate Meter

A rising plate meter looks like a walking stick attached to a horizontal "plate" that can rise and fall as the meter is pressed into the soil (Fig. 1).

Figure 1. Farmworks® rising plate meter.

The plate compresses the forages underneath it, so it actually measures the *density* of the pasture rather than the height. This means that a sparse pasture will give a lower reading than a dense pasture of the same height, and in two pastures with similar forage density, the taller forage will give a higher reading.

Some rising plate meters count the number of readings and record a continuous cumulative measurement. The most convenient rising plate meters also can average the cumulative reading from any number of measurements taken in a single paddock (Fig. 2) and can then be zeroed for the next paddock.

Figure 2. Cumulative reading, number of readings (c=counts) and average reading.

Taking Rising Plate Meter Measurements

Pastures are usually not uniform, so when estimating pasture dry matter, the more rising plate meter readings that are taken, the more accurate the estimate will be. Take at least 30 measurements, one every few steps, while walking through the entire paddock in a "lazy W" pattern (Fig. 3), pressing the rising plate meter straight down until it reaches the soil surface. The plate will be lifted by the forage as the tip of the meter is pressed down and will fall back to the starting position as the meter is lifted with the next step.

After sampling the whole paddock, stop and record the average reading for that paddock. If the rising plate meter does not calculate an average reading for the paddock, calculate it manually by dividing the cumulative rising plate meter reading by the total number of measurements taken.

The next step is to convert the average pasture height to forage dry matter per acre, which can be done using conversions provided by the manufacturer or by university personnel. Several commercial rising plate meters are available, and instructions for constructing and calibrating a plate meter are also available (Rayburn and Rayburn, 1998).

Figure 3. "Lazy W" pattern in a single paddock of a larger rotationally grazed pasture.

Calibration Equations for Different Forage Plant Species

At Utah State University, calibration equations for a number of pasture species have been developed for use with the Farmworks® rising plate meter (Table 1). To use these equations to convert Farmworks® rising plate meter readings to pasture dry matter per acre, multiply the average reading for a given species by the conversion factor listed next to the species name.

Dense low-growing species like perennial ryegrass have higher conversion factors than taller, less dense species like intermediate wheatgrass. A similar comparison of height and density is illustrated for forage legumes in Fig. 4.

Table 1. Multiply Farmworks® rising plate meter readings by these conversion factors to determine lbs. of dry matter (DM) per acre.

Species	Conversion Factors	Pasture DM (lbs/ per acre)
LEGUMES		
Alfalfa	127	
Birdsfoot trefoil	143	
Cicer milkvetch	126	
Crownvetch	124	
Kura clover	135	
Sainfoin	113	
White clover	144	
GRASSES		
Creeping foxtail	127	
Intermediate WG	119	
Meadow brome	128	
Orchardgrass	116	
Perennial ryegrass	161	
Reed canarygrass	93	
Smooth bromegrass	122	
Tall fescue	150	

Instructions for collecting and using calibration samples to predict pasture dry matter using pasture rulers or other rising plate meters are contained in the USU Extension publication *Guidelines for Visual Assessment of Herbage Mass in Pastures* (AG/Forages and Pasture/2004-01).

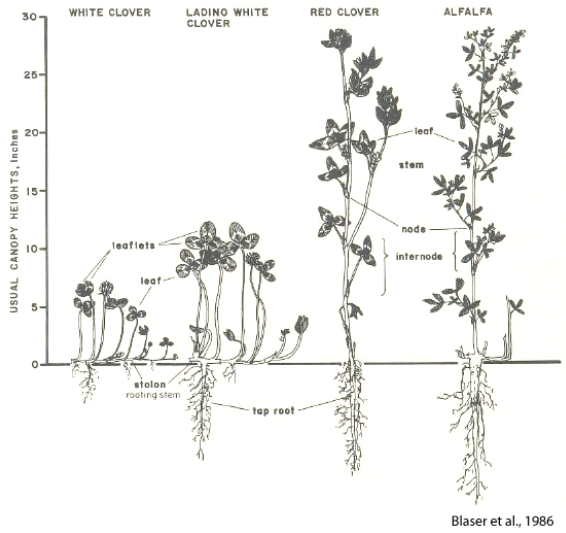

Figure 4. Horizontal stems of white clovers compared with upright stems of red clover and alfalfa.

Using a Rising Plate Meter in Pasture Management

To maximize intake and gain, pastures should be grazed just as the growth matures, at a stocking density high enough to remove grass leaves but not stem bases. Most pasture grasses store the carbohydrates needed for regrowth aboveground in their stem bases (Brink, 2007). After forages are grazed, these carbohydrates are needed to maintain root systems and support new shoot growth. If a pasture is overgrazed and stem bases are removed, roots die and the ability of forage plants to extract water and nutrients from the soil is restricted, reducing the competitiveness of desirable forages and leading to weed invasion. On the other hand, if a pasture is left ungrazed too long, forages will become too mature, and plant proteins and carbohydrates will decrease relative to fiber, which also becomes less digest-ible.

A good grazing height for most forages is 3 to 4 inches; for shorter grasses like perennial ryegrass or Kentucky bluegrass, a 2-inch stubble is good. For cattle, a dense pasture 6 to 10 inches in height provides the ideal bite size, facilitates the most efficient grazing and the greatest intake (Muller, 2004). A stubble height of 3 to 4 inches corresponds to 1100 to 1300 lbs. of forage dry matter per acre for cool-season (temperate) grass and legume pastures (Griggs and Pack, 2004). Some legumes, most notably alfalfa, accumulate carbohydrates and proteins for regrowth underground, in their crown and roots. Rhizomatous grasses like smooth bromegrass use their underground stems (rhizomes) for storage, and stoloniferous legumes like white clover use their aboveground stolons (stems) for storage. However, common pasture grasses like orchardgrass, meadow bromegrass, tall fescue and perennial ryegrass are bunchgrasses, and use the bases of their leaves and stems (stubble) for storage.

The following examples will demonstrate how the forage dry matter requirement of a herd of beef or dairy cattle can be estimated, and how the rising plate meter can be used to estimate the dry matter available in the pasture on a per-acre

basis. With this information, the size of paddocks needed for rotational stocking can be estimated and then adjusted by checking the forage dry matter remaining after the animals have been moved to the next paddock.

DAIRY EXAMPLE

A 1200-lb dairy cow can consume 35-40 lbs. of high quality forage dry matter per day, or 20 lbs. of forage dry matter in a 12-hour grazing period (Muller, 2004). A sufficiently large pasture subdivision for a herd of 50 1200-lb. dairy cows grazing for 12 hours will therefore need to provide about 1000 lbs. of grazeable forage dry matter.

After walking the pasture that will be next in the rotation with a rising plate meter, the average rising plate meter reading is found to be 17.5 units. If the pasture contains birdsfoot trefoil (Fig. 6A), this rising plate meter reading corresponds to 2500 lbs. of dry matter per acre. Of this total, about 1200 lbs. per acre should be left in the pasture as stubble dry matter after grazing to support pasture regrowth. This means there is 1300 lbs. of grazeable or available forage dry matter per acre. Since the herd that will graze the next paddock needs 1000 lbs. of forage, the size of the next paddock can be calculated as follows:

$$\frac{\text{1000 lb. forage DM needed}}{\text{(2500 lb. total DM/ac) - (1200 stubble DM/ac)}}$$

equals

$$\frac{\text{1000 lb. DM needed}}{\text{1300 lb. available DM/ac}}$$

equals

0.77 ac

The paddock area needed to provide 1000 lbs. of forage dry matter is about 0.77 (3/4) acre for the next 12-hour period. Rising plate meter readings taken following grazing in this paddock can be used to double check stubble dry matter and adjust stocking densities to increase or decrease the post-grazing paddock dry matter in subsequent paddocks in the rotation.

BEEF STOCKER EXAMPLE

Growing beef cattle will consume pasture dry matter in amounts ranging from 2.5 to 4.0% of body weight each day. Compared with mature beef or dairy cows who are gaining weight slowly due to gestation, young beef stock are growing rapidly. This means that for a constant number of calves, paddock size will need to increase over the course of the grazing season. A herd of 50 500-lb. calves have a total live weight of 25,000 lbs. At 4% of body weight (25,000 lbs. x 0.04) this 50-calf herd can consume 1000 lbs. of birdsfoot trefoil pasture dry matter per day, and (similar to the example above) need an allotment of 3/4 acre *for the whole day*. However, if these calves gain 2.5 lbs. per day, after 60 days they will weigh 32,500 lbs. and their daily forage requirement will be 1300 lbs. of grazeable dry matter, or a 1-acre birdsfoot trefoil pasture. After 120 days they will weigh 40,000 lbs. and will need 1600 lbs./day or 1.25 acres of grazeable birdsfoot trefoil each day.

Calibrating a Rising Plate Meter

To calibrate a rising plate meter, samples are clipped from an area the same size as the plate on the meter after a single meter reading is taken in a given location. Figure 5 shows a 3-sided square "quadrat" that is slipped under the meter after a reading is taken and used as a guide for clipping the calibration sample. It has an interior area equal to the area of the meter's plate.

Figure 5. Plate from Farmworks® rising plate meter and a three-sided quadrat used to take calibration samples for herbage DM.

Once the meter reading is recorded, all the forage within the quadrat is cut close to the ground, dried and weighed. The rising plate meter is calibrated by taking many readings of the same plant species or mixture at different stages of growth and at different times during the season. It's important to remember that the rising plate meter reading for a paddock is always the *total* forage dry matter in the paddock. This allows both the post-grazing stubble and the pre-grazing dry matter to be determined.

The upper calibration chart in Figure 6 was developed for the legume birdsfoot trefoil, and shows the overall relationship between rising plate meter readings and birdsfoot trefoil dry matter. The lower chart in Figure 6 was developed for a mixed pasture containing perennial ryegrass, orchardgrass, tall fescue, quackgrass and white clover. The calibration factors in Table 1 were developed for a Farmworks® rising plate meter like the one pictured in Figure 1. It is possible to convert calibrations developed for one rising plate meter to another type of rising plate meter (Rayburn et al., 2007).

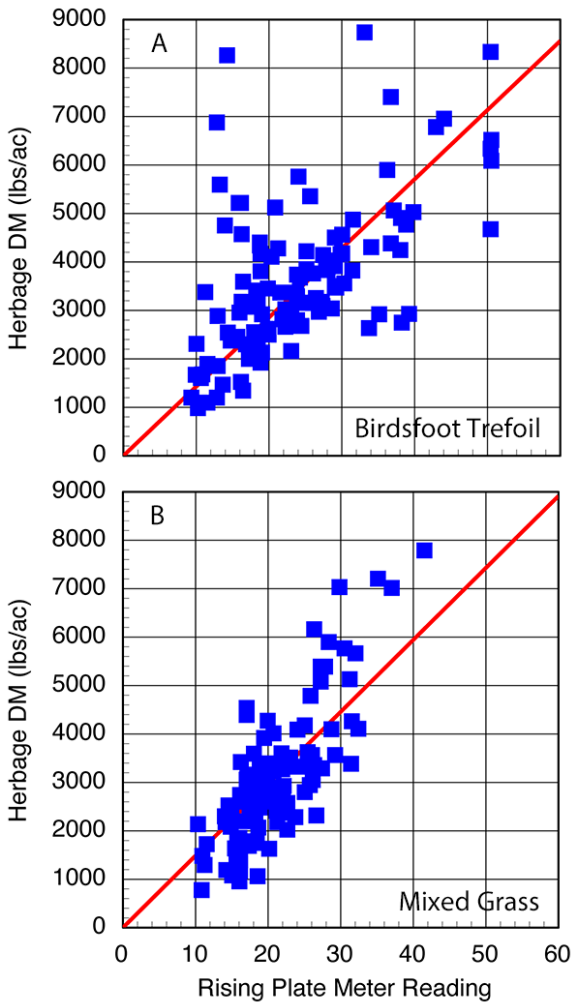

Figure 6. Charts of pasture DM in lbs. per acre for birdsfoot trefoil (A) and a mixed grass pasture (B) plotted against average rising plate meter readings.

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