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Using a Rising Plate Meter to Measure Pasture Growth: A Practical Guide

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Knowing pasture yields is very helpful for all livestock operations, especially cattle farms. High animal productivity is only possible with access to adequate quantities of high-quality forage. Previous research has shown a correlation between forage height and pasture yield. Height can be measured with tools as simple as a ruler, but this method often does not produce accurate yield estimates because pasture density is not taken into account.

There are better ways to quickly take multiple measurements of pasture height across a field, such as the rising plate meter. The rising plate meter allows an accurate estimation of forage yield because of the correlation between height and density and forage mass. Visually estimating forage mass may be easy for seasoned producers, but for most of us, a plate meter is a helpful tool to guide us through the process. Using this method will not give a perfect yield estimate, but this information will provide valid yield comparisons between pastures.

A plate meter consists primarily of a weighted plate that moves up and down a shaft as the plate is placed over the sward. The forage is then compressed until it can support the weight of the plate. The distance from the point where the shaft contacts the ground and the plate is referred to as the plate height. Plate meters can be called by several names, such as falling, resting, weighted disk, or rising plate meters.

Figure 1. Plate meter made by Jenquip.

There are many different constructions of plate meters, some of which can be expensive. Luckily, there is a version of the plate meter called a falling plate that can be easily made with some simple materials found at a hardware store. Ed Rayburn designed a falling plate meter that only costs about $25. It is constructed from 0.22-inch acrylic plexiglass cut in an 18-inch square and uses a grazing stick or ruler to measure height. A detailed explanation and how-to guide to make and use Rayburn's falling plate meter is located in the appendix section of this publication.

How to Use a Plate Meter

A rising plate meter is used by walking throughout the pasture and stopping periodically to take a reading by pressing the instrument into the sward. Typically, 50 or more readings are taken per pasture. A rising plate meter consists of a lightweight metal plate that is free to slide up and down on a grooved shaft, an odometer mounted on the shaft to record the movement of the plate, and a tally counter mounted to the very top of the plate meter. The plate will move up the grooved shaft in proportion to the height and density of the forage at each spot. The grooves on the shaft are a half-centimeter apart, and the odometer records how high the plate is from the ground. The odometer keeps track of the accumulated height from multiple measurements. The tally counter must be clicked manually each time a measurement is made. For the purpose of this article, a reading will be called a "click," in reference to the clicking sound made by the counter. Rising plate meters are designed to estimate yield on pastures at a vegetative growth stage.

Select reading locations at random, avoiding stemmy weeds that are not representative of the field. Also, it is not practical to use a rising plate meter on pastures that have been recently mowed or that are full of seedheads. Another important practice when using a rising plate meter is to always take a reading with the shaft perpendicular to the ground. The plate should drop straight down, as dropping the plate at an angle makes the reading inaccurate. Plate meter calibrations are typically done by calculating linear regressions from the odometer measurements against corresponding clippings and dry weight. The rising plate meter shown in Figure 1 is made by Jenquip, a New Zealand-based company.

The rising plate meter gives a quick and accurate measurement of the compressed height of a pasture, but not a direct measurement of the actual dry matter present. To estimate actual dry matter, an equation is needed that relates the compressed height to pasture yield for the forage type being measured. A 2020 University of Georgia publication, *Using a Rising Plate Meter to Measure Pasture Mass*, provides equations for common forages grown in Georgia, but few rising plate meter equations are available that have been generated from Kentucky pastures. The next section of this publication will explain how one equation was developed from tall fescue-dominated pastures in the state.

Calibrating the Jenquip Plate Meter for Kentucky Pastures

Ten pastures, two each from five different Kentucky farms, were evaluated for botanical composition during the summer of 2021 and then clipped to measure dry matter yield. Nine out of the ten pastures were predominantly tall fescue, with white clover being the next most common species. The farms were located across the state of Kentucky. The average breakdown of species is listed in Table 1.

The number of forage samples clipped to develop the calibration equation varied with pasture acreage. For this study, 10 clippings were taken when the acreage was below nine acres, and 15 clippings were taken for fields of nine acres or more.

To facilitate clipping calibrations, a circular plywood frame was made to fit perfectly over the plate. The frame was placed over the plate meter after the height was taken, and then the plate removed. All of the sward within the plywood frame was then clipped with handheld hedge trimmers and bagged in paper bags. The bagged forage samples were dried in an industrial dryer at 125 degrees Fahrenheit for five days and weighed to determine the dry weight.

Table 1. Average species composition of study pastures, measured by percent of total cover.

Species Present	Amount (%)
Tall fescue	32
Kentucky bluegrass	16
White clover	12
Orchardgrass	5
Nimblewill	8
Crabgrass	6
Foxtail	3
Weeds	7
Bare soil	3
Bermudagrass	5
Other forages	3

The number of clicks or readings taken also varied with acreage. For pastures under nine acres, 50 clicks were taken, although more could be taken if the minimum number of clicks does not cover the area of the pasture completely. For pastures of more than nine acres, 100 clicks or more were taken. Only one of the pastures in this study was greater than nine acres, so 100 clicks were taken for that one pasture. While we applied these guidelines for the purposes of this study, other research has stated pastures of three to five acres should have a minimum of 100 clicks, or sample locations.

Ideally, calibration equations should be made from pure stands of individual forages, because each species may have a different relationship between compressed height and yield. However, this is not usually practical. Most pastures are not monocultures; they consist of many species of grasses and legumes. In this study, the pastures were actively being used for cattle grazing and hay production to create a more realistic equation for yield estimation. Calibration equations are typically developed based on pasture type. In the case of this study, the "pasture type" was predominately cool-season, grass/legume forage mixture.

One year after the initial study was completed, clipping and rising plate meter data was collected from pastures A and B at farm 6 to validate the equations developed from the previous year. As mentioned previously, this method does not provide a precise measurement of yield but does represent an accurate comparison between the compressed heights from different pastures or from different periods of growth.

Results

All of the five farms sampled across Kentucky were used to create a calibration equation for a predominately cool-season, grass/clover pasture mixture to estimate potential yield. A linear regression was produced, using the average compressed pasture height and yield (lb/ac) to come up with the equation (Figure 2). In this study, the intercept has been forced to zero due to the concept that at zero height (in) there will be zero yield (lb/ac). Previous research has shown that the relationship between forage density and height can result in a second order relation with zero intercept.

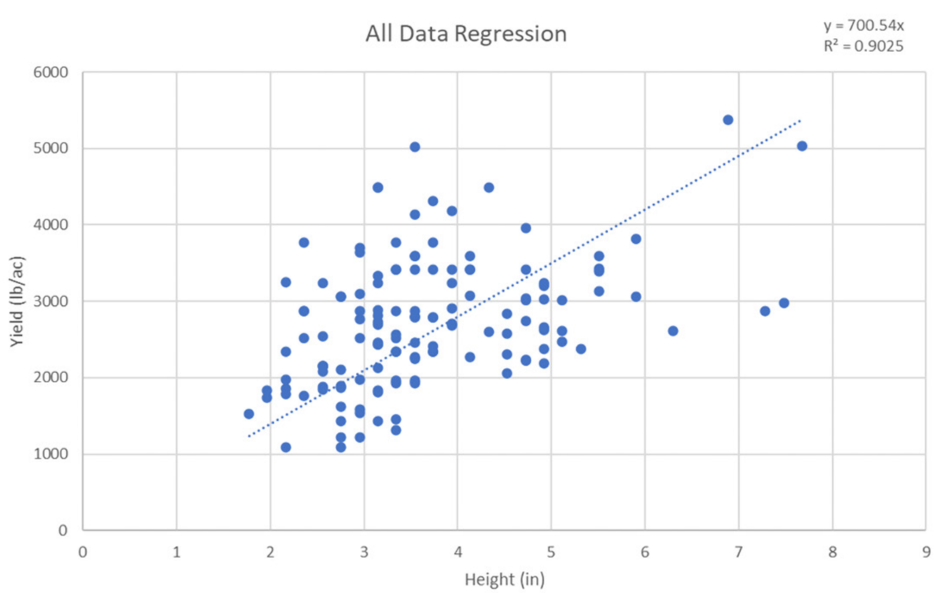

Figure 2. Data from the five farms across all the sampling dates in 2021 was combined into one linear regression. The regression equation is y = 700.54x, where y = yield and x = plate meter height in inches.

Step-by-Step Instructions for Using the Jenquip Rising Plate Meter

Remember that no pasture is completely uniform, and results can be influenced by variables like mole hills, grazing pressure, and topography. To take field variability into account, take at least 50 readings for pastures that are 9 acres or less. For larger pastures, use 100 readings or more.

Step 1. Start either in the front or back of the pasture and be sure to record the start number on the odometer (or set the counter to zero, if that option is available). Take the first reading by setting the plate meter down on the sward, remembering to keep the shaft perpendicular to the ground. Let the plate settle until it has compressed the forage below it and the base of the shaft rests on the ground. As the plate floats up the shaft, the odometer records the distance moved up the shaft. This is the first click from the counter mounted on the shaft. In this example, a 4.5-acre pasture was used.

Step 2. Repeat this process while zigzagging throughout the pasture, making sure to click the counter each time the plate meter is set down. The zigzag pattern helps to ensure the whole pasture has been covered for the yield estimation.

Step 3. If the pasture has not been covered after 50 clicks, then continue measuring more points until you have completed the field. More measurements will improve the estimation. Fifty clicks should be the minimum number of readings.

Step 4. Once the entire pasture has been covered, record the last odometer reading located on the shaft and the number of total clicks completed throughout the pasture. This data will be found on the tally counter mounted on the top of the rising plate meter.

Step 5. Subtract the beginning odometer reading from the ending odometer reading to determine the total accumulated height measured in the pasture and record that number. To convert this value to centimeters, divide the odometer difference by two, because the rising plate meter measures in half centimeters. Divide centimeters by 2.54 to determine total inches measured. Then divide total accumulated inches of height by the number of readings (clicks) to determine the average height in inches.

Step 6. Convert the average height in inches to dry matter yield using a calibration equation for forages similar to that in your pasture. In this case, dry matter yield equals average plate meter height in inches multiplied by 700.54 for typical Kentucky pastures.

For more detail on the calculations in Steps 5 and 6, see the dry matter yield calculation example.

Summary

The rising plate meter is a very helpful tool for producers that is relatively easy to use and a good indicator of vegetative forage yield in tall fescue-dominated stands. Monitoring forage yield in pastures can be one way to increase daily livestock gains by ensuring that forage intake is not limited. Plate meter data can also be an indicator to implement management practices to increase growth. Most pastures in Kentucky and other parts of the country are not monocultures; therefore, the accuracy of yield estimates from rising plate meters will vary depending on how well the forages in your field match those in the calibration dataset. For tall fescue-dominated pastures in the vegetative stage in Kentucky, we estimated that each inch of compressed forage represents 700 pounds of forage dry matter per acre. Your results may vary, but it is better to have a reasonable yield estimate than no estimate at all.

Dry Matter Yield Calculation Example

Odometer Readings			
Start	**Stop**	**Difference**	**Counted Clicks**
83,478	84,408	930 half-centimeters	51

$$\frac{930}{2} = 465 \text{ centimeters} \qquad \frac{465}{2.54} = 183.07 \text{ inches} \qquad \frac{183.07 \text{ in}}{51 \text{ clicks}} = 3.58 \text{ inches}$$

Yield = 700.54 x 3.58 inches = 2,507.93 (lb/acre measured to the soil surface)

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Appendix: How to Build and Use Your Own Plate Meter

Ed Rayburn, retired forage extension specialist with West Virginia University, has developed a plate meter that can be made at home at a much lower cost than that of a commercial rising plate meter. To construct the Rayburn plate meter (often called the West Virginia falling plate meter), purchase a 0.22-inch acrylic plexiglass sheet and cut out an 18-inch square section. Then drill a 1.5-inch hole in the center of the plate. A grazing stick or 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 grazing stick . The cost for this device is estimated to be around $25. A drawing of the Rayburn plate meter is shown in Figure 3. The 2003 publication by Ed Rayburn listed in the reference section, "A Falling Plate Meter for Estimating Pasture Forage Mass," provides the complete details for building this plate meter. Users of this device may find it helpful to purchase a handheld tally counter for keeping track of the number of measurements.

Table 2 contains the data on pasture density related to falling plate height using the Rayburn device (data provided courtesy of Ed Rayburn, West Virginia University). This chart is needed to estimate forage mass from pasture height when using Rayburn's falling plate meter. Note: the yield data in Table 2 is based on mixed grass/clover stands of perennial cool-season forages.

Table 2. Pasture density estimation using West Virginia falling plate meter.

Measurement (Falling plate ht. in inches)	Forage Mass (lb of dry matter/acre)		
	Thin	Average	Thick
1	350	680	1020
1.7	580	1070	1570
2.3	810	1440	2070
3	1050	1770	2500
3.6	1300	2080	2870
4.2	1550	2370	3190
4.9	1810	2620	3440
5.5	2080	2860	3640
6.2	2350	3060	3770
6.8	2630	3240	3840
7.4	2920	3390	3860

Source: "Estimating Pasture Forage Mass by Forage Height," by Rayburn and Lozier, 2016.

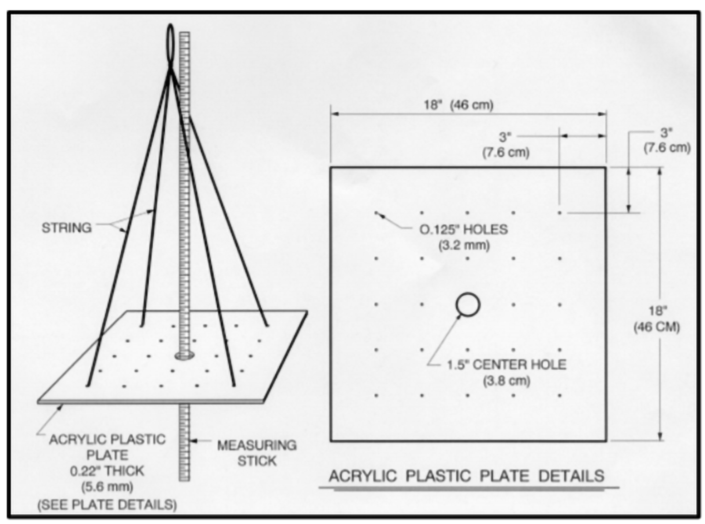

Figure 3. Illustration of the West Virginia falling plate meter. (Image courtesy of Ed Rayburn)