Pasture Productivity Pail Booklet

University of Minnesota
EXTENSION

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Pasture Productivity Booklet

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The Ultimate Guide to Testing Electrical Conductivity of Soil

Hanna Instruments

Allison Hubbard

Measure the Bulk EC of Your Soil

Bulk electrical conductivity of soil measures the total conductivity. Total conductivity includes the EC of the soil, air, and moisture in your sample. All these things carry charged ions that would read as EC. This reading is very useful; you can calculate your pore water conductivity and saturated extract conductivity from the result. You would need to know your water content to perform that calculation (how much water there is in your soil).

How To Measure the Bulk EC with your Direct Soil EC Meter

1. Pick your testing location.
2. Rinse the testing probe with deionized water, and make sure it is dry.
3. Check the soil and ensure that the soil is moist.
4. Use a ruler or auger to make a hole in the soil. This keeps the testing depth consistent.
5. Insert your soil conductivity tester directly into the soil, and take your measurement.

Using a fixed 2%/C temperature correction coefficient, this EC tester has a built-in temperature sensor so that samples are automatically compensated for temperature variations.

https://www.hannainst.com/hi98331-soil-testtm-direct-soil-ec-tester.html

https://www.grainger.com/product/20VC74?cm_mmc=PPC:+Google+PLA&ef_id=CjwKCAiAmrOBBhA0EiwArn3mfERVuaqDR8mCxebpfowwLO9udT9eqtvNwE0qRp03X8kwHYRXtmvjyBoCdicQAvD_BwE:G:s&s_kwcid=AL!2966!3!264955916555!!!g!439177135836!&gucid=N:N:PS:Paid:GGL:CSM-2295:4P7A1P:20501231&gclid=CjwKCAiAmrOBBhA0EiwArn3mfERVuaqDR8mCxebpfowwLO9udT9eqtvNwE0qRp03X8kwHYRXtmvjyBoCdicQAvD_BwE

Item 3

Instructions for Using: NRCS Grazing or Pasture Stick

Courtesy of USDA-NRCS, Iowa

The USDA-Natural Resources Conservation Service (NRCS) grazing stick is a tool for use in rotational grazing. It is a good educational tool for getting started in rotational grazing. The following information can be obtained when using the grazing stick:

- When grazing should be started
- When livestock should be moved to another pasture
- Average pasture growth rates
- Rotation lengths, number of days when pasture is not being grazed
- Estimate of the amount of available dry matter

When to start and stop grazing: Place the stick vertically into the forage. Use the inch scale to measure the height of the grass at the top of the thickest part of the canopy. Measure about 10 spots typical of the pasture to obtain an average forage height. Begin grazing when forage heights are between 6 and 12 inches for pastures containing orchardgrass, timothy, bromegrass, perennial ryegrass, tall fescue and legumes such as red clover, and trefoil. Grazing should begin at a height of 5 to 6 inches for pastures containing lower growing plants like bluegrass, redtop, sweet vernal grass, fine leafed fescues, and white clover. Reed Canarygrass is not palatable when it is mature, so target grazing this species at no more than 6-7 inches, and leave 4 inches of stubble.

Pastures exceeding heights of 12 inches can be grazed by larger livestock species, such as cows. Sheep and even horses may tend to avoid the taller plants and graze around the base for shorter stems. If grazing cows on taller heights, be aware of nutritional requirements of the animals you are grazing, and mange appropriately, keeping a close eye on livestock body condition scores. Milk production may suffer on forages that are too mature, and most lactating cows are managed on pastures that do not exceed 10 inches in height, and are leafy, green and succulent.

Taller forages will also tend to be less palatable, in general, to animals. If pastures get ahead of you in maturity, consider taking a cut of hay from the field(s). Another strategy that is used to get animals to utilize over-mature pasture is to mow a day's worth of forage at a time and leave it to wilt for half-day or so before turning cows onto it. They will usually consume it as they would hay. Again, the caution here is that grasses that have produced a seed head and gotten "stemmy" will have much lower protein, digestibility, and nutritional value.

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Move livestock to a new pasture when the forage height has been reduced to 3 to 4 inches for the taller species and to about 2 inches for the lower growing species (black bar on stick). The more leaf material that is left behind, the better the plants will respond and re-grow. It is important not to graze below these heights, and even taller "stubble" left behind is better. If the forage is grazed too short, then the plants have to use their root reserves to start regrowth. This will slow the rate of regrowth and reduce the total amount of regrowth, impacting productivity. It may be necessary to supplement the forage with hay or another feed to prevent overgrazing.

Remember these adages and discipline yourself to manage by them for the best possible pastures:

"Take half, leave half."

"It takes grass to grow grass."

Tall vegetation, not eaten by the animals, can be clipped to a height of 4 inches to promote regrowth and to control undesirable weeds. Clipping weedy pastures twice a season will help to keep weeds in check and promote forages.

One exception to these height recommendations is the first time a pasture is grazed in the spring. Grazing should be started when new spring growth reaches 4 inches in height and grazed until the height is 2-3 inches. This will keep pastures from maturing too fast and move the animals rapidly through all the pastures to establish a staggered forage regrowth pattern necessary for the rest of the grazing season.

A second exception to the recommended grazing heights is when soils are so wet that punching is a problem. Delay grazing until the soils are dry enough to support the weight of the animals without punching. In these circumstances, pasture may get more mature than you desire. See above for ideas to deal with this.

The side of the stick with the black (or red if your stick is wooden) tip also gives the average growth rates expected in pounds of dry matter per acre per day for different times of the year. Also, rotation lengths are given. The rule of thumb is to allow the pasture to regrow undisturbed for 15 days in spring or early summer and 30 days or longer in mid-summer and fall before turning the animals back into the pasture to graze. This period of undisturbed regrowth is very important for a pasture to be productive. The number of days is a guideline. Actual management decisions should be based on grass height, speed of regrowth, and other considerations.

A third exception to these recommendations is when there are hot, dry conditions. Rotation lengths (number of resting days) need to be increased, and a longer height needs to be left for recovery.

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How to estimate the amount of dry matter for grazing: This estimation uses the side of the grazing stick with the dots grid and the tables on the right side of the stick.

1. First, the average height of the forage needs to be determined as described above.
2. Next, slide the stick sideways into forage that is 5 to 8 inches tall, depending on the species. With the stick flat on the ground and the forage covering the stick, count the number of dots you can readily see.
3. Go to the table on the right side of the stick and choose the column of numbers that matches the number of dots counted.
4. Rotate the stick to find the best description of the forage present. This gives the estimated pounds of dry matter per acre per inch of growth. These tables assume that there has been some level of management, such as liming or applications of N (nitrogen fertilizer) on grass-only pastures.
5. To estimate the amount of forage available for grazing per acre, subtract 3-4 inches (remaining leaf and stubble) from the average height of the pasture and multiply by the estimated pounds of dry matter per acre per inch value obtained from the table.

Now, other estimates can be made by knowing the number of animals, type and size.

Rule of thumb: Grazing animals consume 2.5 to 4.0 lbs. of dry matter per 100 lbs. of body weight per day, depending upon species and production stage. Lactating dairy cows eat 3.0 lbs. of dry matter per 100 lbs. of body weight per day.

Examples: 125 lb. sheep eats 3.1 lb. dry matter/day

1000 lb. non lactating cow eats 25 lb. dry matter/day

1200 lb. lactating dairy cow eats 36 lb. dry matter/day

1300 lb. lactating dairy cow eats 39 lb. dry matter/day

This information can be used to determine how many animals can be grazed on the pasture for a given period of time, how long the pasture can be grazed, or how many acres of pasture is needed for a given number of animals for a given period of time. This information is useful for making sure there is enough forage in the days ahead and for fine tuning planned rotations and pasture layouts. Dry matter fed in the barn or supplemented on pasture can be subtracted from the total daily requirement.

Some animals will consume more than needed if it is available. Dairy cows, however, tend to have a challenge consuming enough succulent pasture to meet their DM requirements. More frequent moves (2 or more times per day) will reduce fouled forage and encourage animals to get up and graze.

Item 3

The longer animals are in one paddock, the more fouling and trampling will take place, and consequently there will be less available palatable forage. Trampling and fouling may account for reductions of available forage in the range of 10 to 50%, so it is a good idea to take this into account when planning paddock size, stocking rate, or stocking period.

Calculate paddock size:

1. Use the pasture stick to estimate the amount of forage dry matter available per acre.
2. Calculate the amount of forage needed for the animals you have X .5 (to account for fouling, trampling, and other wasting, or by .7 if moving to fresh ground every one to two days) X the number of days they will be on a paddock until their next move.
3. Number 1 ÷ number 2 = paddock size in acres needed.

    One acre is roughly 40,000 square feet, or 200 x 200

For a demonstration, see eOrganic's video, Calculating Dry Matter Intake:

http://www.youtube.com/watch?v=bSYflqjP6B0

(Updated April 2013)

Monitoring Pasture Quality Using Brix Measurements

Novel Ways, Hamilton

Toby Balsom, Graham Lynch

How do I take accurate brix measurements?

After doing multiple tests and consulting with farmers who have been using brix readings for years, a standardised way to sample grass using a brix meter is proposed.

1. Choose a clear sunny day, where bad weather is not expected for the next 24 hours or so. If unsure, check the barometric pressure making sure it is around 1013 hPa (NZ only).
2. According to your pasture composition, decide whether you would like to sample the paddock as a whole, or target an individual species such as ryegrass. The latter method should give more repeatability and accuracy.
3. Decide what part of the plant/s to sample, stem or leaves. Preference is to sample the blades of the plant.
4. Pick or cut the grass, according to how a ruminant would eat (approximately 5cm above ground level). If sampling the whole paddock, take many samples from around the paddock which are representative of the whole paddock. If using a selective sample, consider the urine and dung patches throughout a paddock. To get an accurate reading it is recommended to sample the whole paddock.
5. Roll the sample for approximately 60 seconds between your hands, or use a mechanical juicer. (Further tests may suggest a different method at this stage, for example no rolling of the sample).
6. Place sample in the garlic press, and squeeze three or four drops onto the refractometer well or optical plate. Consider temperature of the sample, and if there is a large difference between the sample and the refractometer well, wait for the sample to settle. However this is not recommended at small temperature differences as enzymatic changes will give greater error in the readings.
7. Take the immediate brix reading given by the refractometer, (assuming little temperature difference).
8. Take all grass brix measurements using exactly the same methods, at approximately the same time of day. This will greatly reduce the error between subsequent readings.

Item 4

Brix Level in Your Forage: What Does It Mean?

Mississippi State University Extension Service

Rocky Lemus, Joshua Andrew White

Brix (°Bx) is a unit of measure that has been traditionally used in the wine, sugar, fruit, and honey industries to estimate the sugar (sucrose) or water soluble content (on a percent by weight basis). Forages are composed of many soluble and nonsoluble compounds. Water-soluble compounds (WSC) could include sugars (sucrose and fructans), oils, minerals, pectins, acids, proteins, lipids, amino acids, tannins, etc.

Producers try to use this parameter to estimate energy in forages, but it is important to note that °Bx is not representative of the exact amount of sugar. Brix levels in forage crops could be influenced by many management and environmental factors such as ambient temperature, barometric pressure, soil moisture content, drought, fertilization, crop species, time of day and year samples were collected, maturity, and segment of the forage sampled. For example, in a drought situation, plants tend to concentrate water-soluble carbohydrates in the roots and tissues to survive. On the other hand, nitrogen applications can dilute water-soluble carbohydrates since they can be devoted to growth. In a sense, Brix levels can change due to a dilution effect.

Taking Brix measurements requires a garlic press or other type of press and a portable or digital refractometer or Brix meter. The refractometer uses a known refractive index of a glass prism to measure the refractive index of sap collected from a grass or legume.

The optical Brix meter is one in which a drop of the sample of solution is placed on

Figure 1. (a) Spectrometers. (b) A representative grass sample. (c) Preparing a sample. (d) Sap collection. (e) Brix estimation. (Photos courtesy of Josh White)

Item 4

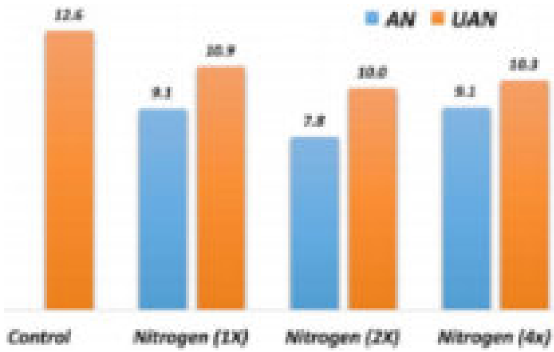

Figure 2. Brix levels in annual ryegrass treated with two nitrogen sources. (Lemus et al., 2012.) AN = ammonium nitrate, 34%; UAN = urea ammonium nitrate, 32%

1X = single application of 50 lb N ac-1; 2X = two applications of 50 lb N ac-1; 4X = four applications of 25 lb N ac-1

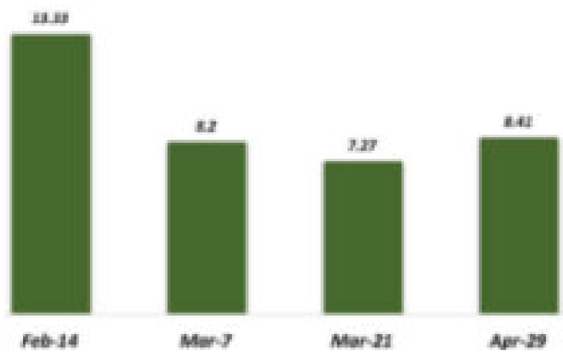

Figure 3. Brix distribution in annual ryegrass throughout the growing season. (Lemus et al., 2012.)

a prism and the result is observed through an eyepiece. This device needs to be pointed in the direction of the light to make sure that the light is totally reflected into the sample. This will create a reflective index and achieve a critical angle. Usually an optical meter contains a thermometer to correct the temperature to 68 degrees Fahrenheit. The digital meter has an internal light source (usually LED) in the prism, and when a sample is dropped in the well, the light does not penetrate the sample and creates a reflective index.

Digital meters are more accurate and easy to calibrate and read. Digital refractometers have the advantage that they automatically correct for temperature variation. Optical refractometers may be slightly less accurate due to human error. This is simply a function of the user making the adjustment so the shadow line falls on the optical scale.

How to Measure Brix

1. Take random plant samples across the pasture in a Z or W pattern to get a good representation of the average water soluble contents. Take samples between noon and 3 p.m. on a sunny day when plants are photosynthetically active and bad weather is not expected for the next 24 hours. Take all grass Brix measurements using exactly the same methods at approximately the same time of day.

2. Sugar in the plant varies from the bottom of the plant to the top. This means that the Brix reading at the bottom of the plant will be higher than at the top of the

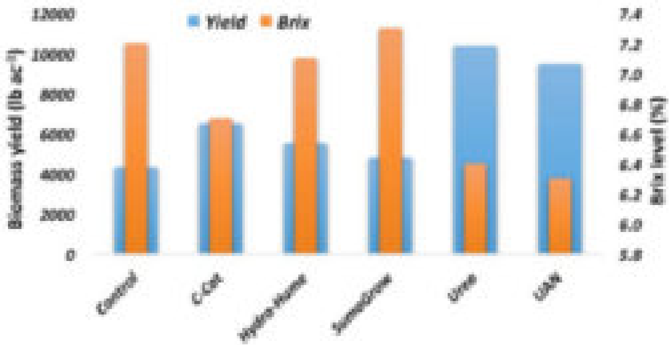

Figure 4. Dilution effect on ºBx levels created by increase in yield with nitrogen application when compared to soil bio-enhancers applied to Sumrall 007 bermudagrass. (Lemus et al., 2013.)

plant. Getting a consistent sample that represents the entire plant is very important.

3. Place the sample in a garlic press or other type of press, and squeeze out the plant sap. Make sure the sample does not have excess water and dirt on it, as water especially will influence the Brix reading. Do not take measurements in wet conditions. If the sample is damp, dry the leaves with a paper towel.

4. To make a reading using an optical refractometer, place three to four drops of the liquid sample on the prism surface, close the cover, and point it toward any light source. Focus the eyepiece by turning the ring to the right or left. Locate the point on the graduated scale where the light and dark fields meet. Read the percent sucrose (solid content on the scale). If using a digital refractrometer, place the sample in the glass chamber and let it equilibrate, and obtain the reading. For example, you have 100 pounds of bermudagrass with a Brix reading of 10 percent. This means there would be 200 pounds of crude carbohydrates per ton if the bermudagrass were juiced and dried to 0 percent moisture. By dividing 200 by 2, we find the actual amount of simple sugars is equal to 100 pounds per ton.

What Do Brix Measurements of Common Forages Mean?

Summer annuals such as sudangrass, forage sorghums, and legumes like alfalfa tend to have higher Brix levels than some of the summer perennial grasses grown in Mississippi. Although there is not a standard level for Brix in forages, quality intervals for Brix measurements in southern forages consumed by beef cattle can range from less than 3 percent (very poor) to 4–7 percent (poor to moderate) to 8–12 percent (good) to more than 13 percent (excellent). This is based on Brix levels collected from several forage species and management practices at Mississippi State University. Keep in mind that cool-season annual grasses like annual ryegrass usually will have higher Brix levels than warm-season perennial crops like bermudagrass and ahiagrass. This is because cool-season species have higher moisture and lower fiber levels than warm-sea son grasses. Additionally, it is more difficult to extract sap from warm-season grasses in the middle of the summer because the plant tissue lacks moisture.

Forage crops with a higher reflective index will have a greater concentration of sugar, protein, and minerals. Crops with higher Brix levels might have an advantage in the fermentation process for silage and baleage. Do not use Brix as a sole variable to estimate forage quality. Although Brix levels have been correlated with taste, palatability, and preference, a forage analysis is the most reliable indicator of the nutritive value of forages. Remember, Brix can be greatly affected by time of year, type of fertilization, time of harvest, and many other environmental factors.

By Rocky Lemus, Associate Professor and Extension Forage Specialist, and Joshua A. White, Forage Variety Testing Manager, Plant & Soil Sciences.

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Item 5

Vice Grip

No Instructions

Item 6

Soil Moisture Monitor

Follow Instructions That Come with Meter

Moisture meter provides data to assess the extent of hidden condensation when checking surfaces before painting, wallpapering, or laying floors or tile. Also helps trace roof leaks and water seepage, and aids in selecting dry lumber. Meter measures soil temperature, pH, and moisture content, as well as the intensity of the sunlight received. 8" long soil probe included.

Item 7

Toxic Plants in Midwest Pastures and Forages

No Instructions

Item 8

Identifying Pasture Legumes

No Instructions

Item 9

Identifying Pasture Grasses

No Instructions

Visual Reference Guide for Estimating Legume Content in Pastures

American Society of Agronomy and Crop Science Society of America

Edward B. Rayburn and James T. Green

Abstract

As the prices of nitrogen fertilizers rise, there is increased incentive to grow legumes for fixing nitrogen and improving forage quality in pastures and hay meadows. From a management perspective, it is important for managers to be able to estimate legume content in the stand. In research, clipping and hand separation is the standard method for measuring legume content. However, this method is impractical for farm managers. Another option is visual appraisal of the percentage surface covered by legumes. The objective of this photo reference guide is to provide a tool that pasture managers can use to assess legume content as it is related to legume cover. For each photo, the area within the quadrat was clipped and hand separated to determine the actual legume content. These photos represent a range of legume content across two ranges of forage mass. By using these photos to help estimate legume content, forage managers should be able to increase the accuracy of their visual estimate of legume content in pastures and aftermath meadows.

Introduction

There are advantages to growing legumes with the grasses in pastures and hay fields. These include providing nitrogen for plant growth and increasing forage quality, thereby reducing fertilizer cost and enhancing animal performance (Blaser et al., 1969; Blaser and Colleagues, 1986; Rayburn et al., 2006).

Legume content in pastures is a dynamic characteristic that is dependent on weather, management, nitrogen accumulation in the soil, pests, and the legume and grass species present. During dry weather, pastures may be grazed closely, allowing white clover to increase and red clover seed to germinate and establish. Proper lime and fertilizer management is essential for legume production. Most clovers grow best when the soil pH is above 6.0 and soil-test phosphorous and potassium are high. When the soil-nitrogen supply is low, as for a newly planted forage stand in a crop rotation after several years of grain, legumes are more competitive (Fig. 1, Site 1). In this situation the legumes fix nitrogen from the air, provide nitrogen first for themselves and then to the grasses as root nodules

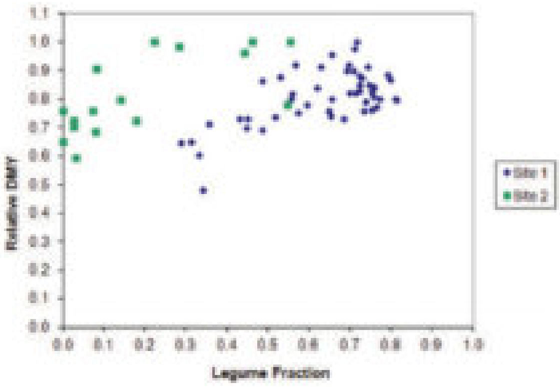

Figure 1. Relationship between legume fraction in the dry matter yield (DMY) and relative yield (1.0 is maximum yield) of total forage at two sites the year after no-till establishment. Site 1 was a grass-clover seeding after 3 years of corn followed 1 year of wheat. Site 2 was a grass–clover seeding on an old hay meadow sod.

slough off, dead leaves decompose, and livestock return manure and urine to the soil. In this situation, legumes dominate and yield is related to high legume content in the stand (60 to 80%). When the soil-nitrogen supply is high, such as in well-developed pasture or hay meadow soils, grasses will be more competitive (Fig. 1, Site 2) since they have access to adequate amounts of nitrogen from the soil. In these sites, relatively low levels of legume content (20 to 30%) are adequate for maximum production. The manager can use the pressure from livestock grazing to shift the balance of grasses and legumes. In general under rotational grazing, leaving a higher residual height encourages grasses, whereas grazing to a shorter height encourages legumes (Brown and Munsell, 1956; Blaser et al., 1969; Blaser and Colleagues, 1986; Belesky and Fedders, 1994). Providing adequate rest intervals between grazing events is a critical management requirement for legumes, especially tall legumes such as red clover and alfalfa.

When the cost of nitrogen fertilizer is high, managing for legumes in pastures becomes important. Being able to visually evaluate legume content is helpful when making management decisions. The objective of this photo reference guide is to provide a tool that pasture managers can use to assess legume content as it is related to legume cover in vegetative, cool-season, rotationally stocked pastures.

Photos of Legume Cover to Help Calibrate the Eye

Vertical photos are good for evaluating plant surface cover as an estimate of botanical composition (Rayburn, 2014). However, the relation between the percentage cover and legume composition is dependent on grass species, legume species, and management (Rayburn et al., 2007). When visually estimating botanical composition, consider plant species, forage mass and age, and associated visible dead material. These sward characteristics will largely be determined by management and environmental conditions. Using photographs of known botanical composition and comparing them to areas in a pasture can help improve visual estimates of pasture botanical composition.

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Figure 2. Sward containing 6% legume, 52% grass, 43% weeds, 5.0-inch canopy height, and 1180 lbs dry matter acre−1 forage mass.

Figure 5. Sward containing 30% legume, 68% grass, 2% weeds, 9.5-inch canopy height, and 2000 lbs dry matter acre−1 forage mass.

Figure 3. Sward containing 18% legume, 80% grass, 2% weeds, 7.5-inch canopy height, and 1775 lbs dry matter acre−1 forage mass.

Figure 6. Sward containing 40% legume, 27% grass, 33% weeds, 8.0-inch canopy height, and 1880 lbs dry matter acre−1 forage mass.

Figure 4. Sward containing 25% legume, 75% grass, 0% weeds, 6.0-inch canopy height, and 1400 lbs dry matter acre−1 forage mass.

Figure 7. Sward containing 55% legume, 23% grass, 22% weeds, 7.0-inch canopy height, and 1677 lbs dry matter acre−1 forage mass.

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Figure 8. Sward containing 61% legume, 24% grass, 15% weeds, 7.5-inch canopy height, and 1780 lbs dry matter acre−1 forage mass.

Figure 9. Sward containing 5% legume, 82% grass, 13% weeds, 13.0-inch canopy height, and 2950 lbs dry matter acre−1 forage mass.

Figure 10. Sward containing 11% legume, 89% grass, 0% weeds, 12.0-inch canopy height, and 3600 lbs dry matter acre−1 forage mass.

Figure 11. Sward containing 16% legume, 74% grass, 10% weeds, 16.5-inch canopy height, and 3270 lbs dry matter acre−1 forage mass.

Figure 12. Sward containing 19% legume, 81% grass, 0% weeds, 9.0-inch canopy height, and 2150 lbs dry matter acre−1 forage mass.

Figure 13. Sward containing 25% legume, 73% grass, 2% weeds, 9.5-inch canopy height, and 3230 lbs dry matter acre−1 forage mass.

Figure 14. Sward containing 34% legume, 66% grass, 0% weeds, 10.25-inch canopy height, and 3550 lbs dry matter acre−1 forage mass.

Figure 15. Sward containing 46% legume, 41% grass, 13% weeds, 8.0-inch canopy height, and 2150 lbs dry matter acre−1 forage mass.

Measuring Legume Content in the Photographed Swards

These vertical aerial photos (Fig. 2–15) were taken of rotationally stocked, cool-season pastures in West Virginia and North Carolina. The predominant legumes in these photos are white clover (Trifolium repens L.) and red clover (T. pratense L.). The predominant grasses in these photos are orchardgrass (Dactylis glomerata, L.), tall fescue (Festuca arundinacea Schreb.), Kentucky bluegrass (Poa pra tensis L.), and crabgrass (Digitaria sanguinalis L.).

The photos were taken at 5 to 6 ft above the ground. In West Virginia, a metal quadrate (1-ft square) on 8-inch legs was used to mark the area of interest. After the photo was taken, a quadrate without legs (1-ft square) was place on the ground, and the forage within the quadrate was cut at ground level. In North Carolina, a 1.5-ft square quadrate was used. After the photo was taken, the forage within the quadrate was cut at 1.0 to 2.5 inches above ground level. At both locations, the forage was hand separated into grass, legume, broadleaf weed, and dead fractions. Botanical fractions were then oven dried. Botanical fractions are based on dry, live plant material.

Organization of Photo Reference Guide

Photos in the reference guide are presented in order of legume content from low to high (Table 1) within two ranges of forage mass. Low forage mass was defined as less than or equal to 2000 lbs dry matter acre−1. High forage mass was defined as greater than 2000 lbs dry matter acre−1. Stand botanical composition of legume, grass, and broadleaf weeds, canopy ruler height (inches), and clipped forage mass (lbs dry matter acre−1) are listed for each photo (Table 1).

Conclusion

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Figure	Legume	Grass	Weed	Height	Forage mass
		%		inches	lbs dry matter acre⁻¹
		Low forage mass (<2000 lbs dry matter acre⁻¹)			
2	6	52	43	5.00	1180
3	18	80	2	7.50	1775
4	25	75	0	6.00	1400
5	30	68	2	9.50	2000
6	40	27	33	6.00	1880
7	55	23	22	7.00	1677
8	61	24	15	7.50	1780
		High forage mass (>2000 lbs dry matter acre⁻¹)			
9	5	82	13	13.00	2960
10	11	89	0	12.00	3600
11	16	74	10	16.50	3270
12	19	81	0	9.00	2150
13	25	73	2	9.50	3230
14	34	66	0	10.25	3500
15	46	41	13	6.00	2150

Table 1. Figure numbers of photographs of pastures of low and high forage mass with their content of legume, grass, broad leaf weeds, canopy ruler height, and forage mass.

Legumes in pastures and hay meadows provide the important ecological services of fixing nitrogen for plant growth and improving forage quality for animal nutrition. This series of photos can help managers train their eye for determining the botanical composition in rotationally stocked, cool-season pastures where the predominant legumes are white and red clover. A manager's skill at estimating legume content will enable them to improve their management of legumes and livestock on pasture.

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Item 11

Indicator Plants that Reflect Soil or Grazing Problems

No Instructions

Guide to Pasture Condition Scoring

United States Department of Agriculture

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Introduction

Pasture condition scoring (PCS) is a systematic way to assess how well a pasture is being managed and resources protected. A pasture rated with a high score is well-managed with productivity (plant and animal) being sustained or enhanced. By rating the key indicators common to all pastures, pasture condition can be evaluated and the primary reasons for a low condition score can be identified. A low rating typically means the pasture has one or more challenges, such as poor plant growth, weedy species invasion, poor animal performance (low forage quantity and quality), visible soil loss, increased runoff, and impaired water quality in or adjacent to the pasture.

The PCS should be performed several times a year during critical management periods throughout the grazing season. The revised "Pasture Condition Score Sheet" (PCSS) should be used to rate individual pastures. Regardless of the time of year selected to do the PCS, the best time to score a pasture is just before it is grazed.

The PCS should be performed—

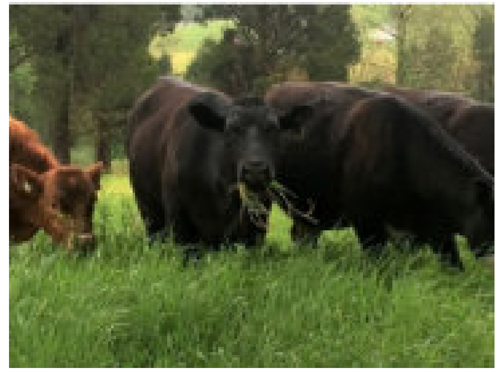
- As a benchmark condition of the pasture.
- Early in the growing season before grazing events occur.
- At peak forage supply periods.
- At low forage supply periods.
- At plant stress periods such as drought or very wet conditions.
- When conservation practices (management) have been fully applied.

For best results, the livestock manager and conservation planners should evaluate the pastures the same time each year to note changes in the condition of the pasture.

PCS results can be useful in deciding when to move livestock or planning other management actions. It assists in identifying which improvements are most likely to improve pasture condition or livestock performance.

The PCS is not a replacement for doing a forage inventory or forage production estimates. The pasture planner should consider other available data such as

The step-point method can provide data for five indicators.



pasture state information in an ecological site description, forage suitability groups, or pasture and hay suitability groups.

PCS involves the visual evaluation of 10 indicators, listed and described below, which rate the pasture vegetation and soils. Rating subjectivity can be reduced by incorporating quantitative measures. For example, using the step-point method for evaluation can provide measured results for five of the indicators (percent desirable plants, percent legume, live plant cover, plant diversity, and plant residue). Also, by pacing to measure the livestock concentration areas and using a shovel to quickly evaluate the soil compaction and soil regenerative indicator, the user of the PCSS and guide can have confidence in each indicator rating and the total score.

On the PCSS, each indicator or factor has five possible ratings, ranging from lowest (poorest) condition (1) to highest (best) condition (5). This objectively identifies the extent of any pasture challenges and helps determine the likely causes. Evaluate each indicator separately. The indicators can then be combined into an overall score for the pasture unit or utilized as individual scores and compared with the other nine indicators. Indicators receiving the lowest scores can be targeted for corrective action. The plant vigor indicator is rated one of the last because previous indicators in the assessment give insight into the plant health and productivity of the pasture.

Indicator Descriptions

Percent Desirable Plants

These are the key species that provide most of the quality forage ingested by the grazing animal being fed. The percent is calculated by dry matter weight.

Desirable Plants.

Desirable species are well-adapted to the site, are readily consumed, show persistence, and provide high tonnage and quality, with sufficient fertility, for a significant part of the growing season. The most desirable species may be grazed first and close to the ground in poorly managed systems and therefore, may decline in prevalence. Meanwhile, other less palatable species that can avoid grazing impacts may increase. These less-desirable species can eventually displace the desirable ones since they are grazed less, if at all. This replacement is important to this indicator and should not be overlooked when the desirability score is low. Some examples of desirable species are orchardgrass, white clover, Kentucky bluegrass, and big bluestem. Refer to your State or regional desirable plant list, and ideally, by grazing livestock type (cattle, sheep, goats) for scoring this indicator. Desirable, intermediate, and undesirable species will depend upon geographic region and livestock type

Intermediate Species

These are adapted to the prevailing site conditions; just as desirable species are. Intermediate species are those which, while eaten, provide low production or lose quality fast, are only eaten by certain species, and often have a short-lived grazing-use period. Intermediates increase as desirable species are selectively grazed out but will be the next set of species to decrease if grazing management doesn't intervene. When adequate forage allotments are presented to livestock, the utilization rate of these species will be less than that of the desirable species. Examples of intermediates are dandelions, wild plantains, barnyard grass, and hop clover.

Undesirable Species

Those that typically are not eaten (rejected) by most livestock, cause undesirable side effects when eaten, or have little or no forage value. They include some woody invaders, noxious weeds, toxic plants, and plants that crowd out more desirable species. A few forages are undesirable during a specific growth stage when they produce toxins. On severely overstocked sites, such as exercise lots, undesirable species will become the only surviving plants. Examples of undesirable species are nimblewill, wild garlic, horsenettle, and buttercup. Record notes in the comment section of the scoresheet for invasive species creating plant pest pressure concerns. Some woody plants such as brush species may be present in the ratings of 1, 2, or 3 on this indicator in amounts economically impacting the herbaceous desirable species and should be noted in the rating.

In this indicator assessment, determine the type and amount of plants within the pasture that the livestock will readily graze that are desirable and intermediate. Estimate visually the proportion (percent) of desirable species present in the entire sward by dry matter weight and score accordingly. The technique of estimating dry weight through visual assessment requires training and knowledge of plant identification. The use of the step-point method is highly recommended for this indicator.

Percent Legume

This indicator measures the average amount (percent) of legume present in a forage stand during the growing season expressed as dry matter weight. The percent legume present at a given time during the growing season can vary considerably, depending upon climate (especially heat), stability, and seasonal growth cycle of the legumes being assessed, the timing and severity or laxity of grazing events, and the timing and level of agronomic inputs.

Legumes are important sources of nitrogen for pastures and improve the forage quality of the pasture mix when they comprise at least 20 percent of total air-dry weight of forage. Deep-rooted legumes also provide grazing during hot, dry periods in midsummer.

Pastures can sometimes be limited in nitrogen, especially ones lacking enough legumes and low in organic matter. Nitrogen excreted by animals often is not distributed well due to lack of pasture management or the location of water, mineral, or shade except in some types of grazing systems such as high-density short-duration grazing. Pastures with few or no legumes will need added nitrogen for increased forage production. Legumes growing along with grasses in pastures have been shown to improve animal intake and performance.

If the proportion of legumes is too high, especially legumes with bloat potential, forage consumption can cause bloat and thus be detrimental to ruminant livestock health. Legume cells rupture easily after ingestion, causing a high fermentation rate to occur in the rumen. This causes the formation of gas bubbles in a stable foam, which can lead to the rumen distending and causing lung malfunction. When bloating legumes, such as clovers and alfalfa (see your State's plant list for additional species), are greater than 40 percent of total forage dry weight, bloat incidence in ruminants is likely without preventative steps.

To perform this indicator, visually estimate the percentage of legume present in the total forage biomass. When conducting the visual assessment on most introduced cool-season legumes (except red clover which has a higher dry weight (90%) and alfalfa (100%)), the estimate will need to be reduced by approximately 50 percent of the visual estimate when converting to a dry matter weight basis. Most legumes have their leaves in the upper part of the plant with only stems below. Thus, the upper part of the plant appears denser visually when compared to grasses which are denser at the base of the plants. For rare cases where legume percentages are greater than 40 percent of the stand, but still are less than 40 percent bloat-type legumes, rate as a 5.

Live Plant Cover (includes dormant)

The percentage of the soil surface covered by live plants is important for pasture production, and soil and water protection. This indicator rates how well your plant solar panel is working. The higher the leaf area, the higher the photosynthetic

Legumes at 6% by dry weight (approximately 10% visual wet).

Legumes at 15% by dry weight (approximately 30% visual wet).

Legumes at 27% by dry weight (approximately 50% visual wet).

activity. A dense stand (high-stem count) of live leaf area ensures, when properly grazed, high animal intake and high sunlight interception for best forage growth. Bare, open spots allow for weed encroachment, increased water runoff during intense rains, soil erosion, and lost production. Attached, standing dead plant material can reduce forage quality, photosynthesis, and new tillering depending on the amount and height.

Live cover assessment can be determined at any time on continuously grazed pastures but is best done closer to optimal grazing heights. On rotational pastures, ideally estimate canopy cover of the paddock the day prior to livestock entry. This will represent the best possible condition. If cover rates fair or lower at this growth stage, management changes are recommended. It can also be used to assess postgrazing events to determine if adequate residual is left or not.

Several things can influence live plant cover, especially time of year, rest period prior to review, forage present, weather conditions, and management. Forages can be easily placed into three different stages.

- Stage one plants are short and immature, having high quality but low production. Stage one plants are good for being a solar panel, but they lack the surface area of stage two, which generally ends right at the early boot stage for grasses.
- Stage two has the greatest live leaf surface area and normally the best forage quality.
- The third stage has maturing vegetation of lower quality and dormant vegetation. Although this stage has the greatest volume of forage available, mature and dormant plants are performing less photosynthesis and forage quality is less.

The management factor in live plant cover is very important. Frequency of grazing, length of grazing period, stop-grazing height, stocking rates and density, length of

How good is my solar panel?

Warm-season grasses are a functional group that when present in the system can ease summer slump periods.

rest period and nutrient management are factors to be managed to achieve the highest production of quality forage for animal growth.

There are times when letting the forage mature longer can certainly be a positive move, especially to grow deeper roots and potentially build soil organic matter. Dormant forage and stockpiled forage may not be the best collector of sunlight but shouldn't be scored as the 5-point category but could still score moderately well on the PCS scoresheet if everything else is met.

Forage stands with dead or dying intact material should be rated lower accordingly, this includes attached standing dead plant material. This material is not collecting sunlight, and it is not desirable for the livestock, although there is some fiber benefit early in the season. Too much standing dead material may cause the forage to be rejected by the grazing animal or lead to other forages being selectively grazed. Note when forage is dormant stockpile for future reference.

Visually estimate percent live cover of all species. Assign a value based on live green leaf canopy. If the estimate is inconclusive, or difficult to complete because of the complexity of species or stage of growth, then use the step-point method to estimate or use a camera-based, accurate green canopy cover measurement tool.

Plant Diversity

This indicator is done by dry matter weight. Forage production varies throughout the grazing season because of changing weather, growing degree days, management, and insect or disease pressures. Increasing diversity can help moderate negative changes. Having multiple dominant desirable forage species in a pasture offers some "insurance" and it's more likely that there is something that can be productive under a wide range of conditions. Warm season grasses for example, can provide quality forage during hot, dry summer periods for areas where adapted, when most cool-season forage tend to go dormant. Low species diversity makes pastures more vulnerable to stress and to changing conditions.

The plant diversity score describes the number and abundance of well-represented forage plants and plant functional groups. For the PCS scoresheet rating, desirable forage species must comprise more than 50 percent of the total biomass to score above a 1. Any time there are more undesirable than desirable plant species, the score will be 1. Refer to your State or regional desirable plant list and ideally by grazing livestock type (species).

The PCSS considers a dominant species to be one that makes up at least 15 percent of the pasture biomass by dry weight. Dominant species contribute substantially to the total forage biomass, and having several similar dominant desirable species helps to spread the production and lower the risk.

A functional group includes plant species that have similar management requirements, biological contributions, and attributes. For most of the United States, the four basic functional groups for improved pastures are cool-season grasses, warm season grasses, legumes, other grazable nonleguminous forbs (e.g., brassicas, forage chicory, dandelion), or a functional group designated by the State. A functional group is counted even if it has no dominant species, if the group collectively makes up at least 15 percent of the pasture biomass.

Plants from different functional groups are most compatible when they can be successfully managed together. Mixed species pastures with at least two functional groups and three or more well represented forage species are generally the most productive. Higher total diversity within a functional group does not ensure higher productivity and may cause animals to avoid some species and graze others heavily, as species differences in palatability and maturity are more likely. The greatest benefit for the grazing system is often achieved by the addition of another functional group.

Adding legumes to the stand increases protein and energy improving forage quality, boosts production, fixes nitrogen for the grasses in the stand, are agronomically sound, environmentally friendly, and economically advantageous. The addition of forbs can provide plants with deeper roots that can bring up nutrients from deeper in the soil profile, provide some additional drought tolerance to the pasture, and often provide highly preferred species that livestock desire.

Some climates may have other functional groups to assess to accomplish the desired outcomes of this indicator.

The PCS scoresheet rating for diversity balances the number of dominant desirable species within a functional group and the number of functional groups to provide a score that indicates general forage productivity and manageability.

Plant Residue and Litter as Soil Cover

Soil cover is important to slow evaporation, maintain and stabilize ideal soil

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Estimate the amount of bare soil. When bare soil is easily seen it is rated a 1. This should not be common.

temperatures, be a carbon and food source for soil life, deter erosion, and to help with water infiltration. Residue is dead plant material in varying states of decay.

Decomposing surface residue is detached plant material that typically creates a light duff layer directly on the soil surface. It is highly subject to microbial activity and is in constant flux. Litter is generally the uppermost layer of detached residue on the soil surface including freshly fallen or slightly decomposed vegetative material. This can include flattened plant material from a recent grazing event with high stock densities that may still be attached. Litter is slightly more stable for a longer period depending on the presence and amount of biological activity.

In a well-managed system, there should always be some plant residue and litter present. Extremely active biological systems, such as an intensely grazed dairy or a beef finishing operation, where vegetation is consistently grazed in the vegetative stage, often lack enough residue and litter most of the season. This can be resolved if needed by increasing the rest period and thus allows more trampling of mature forages onto the soil surface.

Excessively high amounts of residue, especially litter, can interfere and slow down new tiller growth, and tie up nitrogen. These systems often lack enough biological activity. This can be resolved if needed by shortening the rest period, adding more diversity, especially legumes, and increasing stock density.

Grazing events, grazing systems, soil biology and life, weather, and management are constantly changing and often quite fluid. The percentage of ideal cover is not exact but should be in most cases a minimum of 60 percent with good soil biological activity. The higher the requirements of microbial life, the higher amount of residue and litter is needed to support it.

First assess the amount of bare soil. Cover is easily assessed during the step-point method by gently moving the above ground plant cover to one side with your hand or foot if needed to see if soil cover is provided between plants and under the canopy. The soil should be covered by either live plants and tillers or residue. Visually estimate the percent cover between live plants in the stand; the step-point method is a good quantitative way to do this.

Grazing Utilization and Severity

The proper amount and frequency of grazing are critical in maintaining productive pastures. Close and frequent grazing causes loss of vigor, reduces density of desired species and yield, can promote erosion, and have impact on bite size and intake. Differences in species, plant maturity, stocking rate, location and distance to water, shade, and mineral availability may cause uneven grazing to occur.

Grazing utilization and severity are directly related to uniformity of grazing by livestock, except when continually overgrazing. Though an overgrazed pasture may look uniform, the impact of this severity places such pastures in the lowest rating. Uniform grazing results in almost all desirable and intermediate species being grazed to a targeted residual or “stop-grazing” height or slightly higher. Uniform grazing, without overgrazing, usually only exists when proper grazing management techniques are employed and especially where smaller allocations are made.

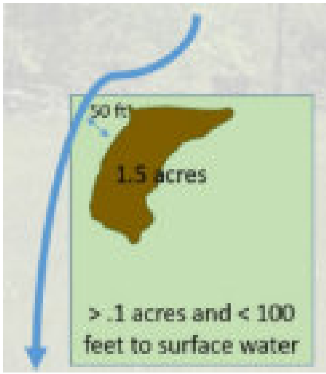
Nonuniformity is spotty or patterned grazing that appears uneven throughout a pasture, with some plants or parts of paddocks grazed heavily and others grazed lightly or not at all. Individual forage species are being selected by the livestock based on their palatability, nutritional value, amount of other forages available, and location in the pasture.

Selectivity is also affected by differences in stage of maturity among species, amount of forage offered to livestock, their length of stay in the paddock, and the livestock stocking density. In most instances, livestock will readily select younger plants over more mature ones. Livestock will also usually refuse to graze where manure and urine have recently been deposited. This leads to a continuing cycle of uneven grazing patterns and reduced efficiency.

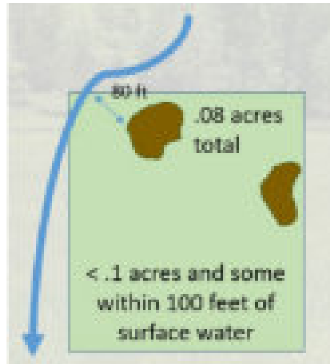
Zone grazing occurs when one end of the pasture is heavily grazed, and the other end is lightly grazed or ungrazed. It often occurs on pastures with long walking distances from one end to the other, especially when shady areas, windbreaks, hay, creep, or mineral feeding and watering sites are a long distance from some parts of the field. Pastures with abrupt topography changes can also cause zone grazing.

For this indicator solely visually assess. When zone grazing is occurring, along with some uneven grazing throughout, rate it a 3. Rate the pasture a 4 if the pasture is uniformly grazed to target residual heights but there is some zone grazing occurring.

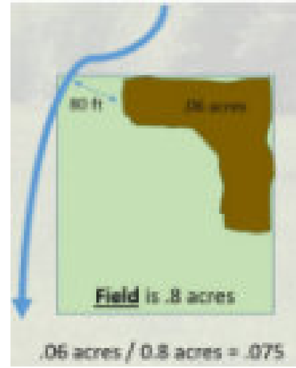
While understocking will lead to more selectivity and the potential for uneven grazing, continual overstocking can result in pastures being uniformly grazed (mowed lawn appearance) but to heights that are too low to maintain all the



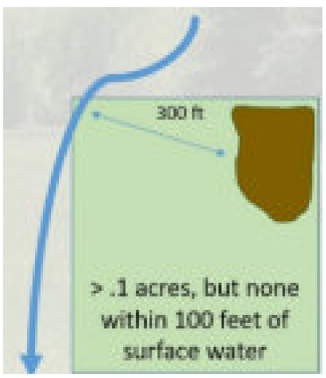
Example of a 1-point rating. Concentration areas are within 100 feet of water body and more than .1 acre in size



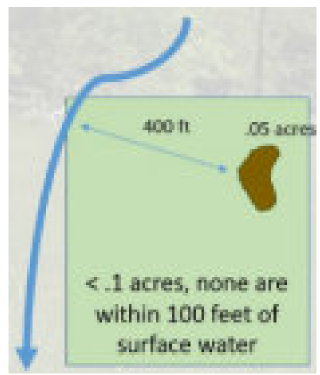
Example of a 2-point rating. Concentration areas are within 100 feet of water body and less than .1 acre in size.



Example of a 2-point rating where the field is less than 1 acre. It receives a rating of a 2.



Example of a 3-point rating. Concentration areas are greater than 100 feet of water body and more than .1 acre in size.



Example of a 4-point rating. Concentration areas are greater than 100 feet of water body and less than .1 acre in size.

desirable species. These uniformly overgrazed pastures should be rated low on the score sheet.

Livestock Concentration Areas

Concentration areas are places in pastures where livestock return frequently and linger near feeding areas, gates, water, mineral or salt, or shade. These areas may have reduced vegetative cover, increased bare ground, and have concentrated animal waste. Livestock trails to and from these preferred areas can create pathways that may increase erosion and become conduits for sediment, nutrients, and pathogens to nearby water bodies.

This indicator addresses the potential impacts on water quality by assessing the size of the disturbed areas and the connectivity to adjacent water bodies through trailing and location. Livestock concentration areas near water sources or with direct conveyance to surface water can create resource concerns. Additionally, these areas on pervious soils over shallow ground water can also create water quality problems from introduced contaminants when close to adjacent waterbodies.

For estimates and comparisons, one square acre is 208’ by 208’ and 10 percent of that or 0.1 of an acre is 66’ by 66’. When assessing pastures that are less than 1 acre, use 10 percent of grazing unit area as an alternative to 0.1 acres, to determine score.

Pace unknown distances and assess the amount of concentration area for this indicator.

Soil Compaction and Soil Regenerative Features

Soil compaction is the diminished pore space between soil aggregates that hold air and water. Compaction reduces a pasture’s ability to infiltrate water by minimizing pore space and increasing bulk density of the soils, negatively affecting hydrologic function, nutrient cycling, and the energy flow throughout the pasture ecosystem. Compaction affects the ability of plant roots to access water and nutrients. Increased runoff resulting from soil compaction creates the potential to transport contaminants such as sediment, nutrients, and pathogens to surface water, degrading water quality.

Roots can be diminished by not only compacted layers, but also from overgrazing and haying. Shallow or sparse roots that do not move deeper in the soil profile, especially when there are no limiting layers, are good indicators these possible management activities are occurring.

Soil regenerative features focus on the condition of plant roots and the abundance of soil life, both of which can improve important soil attributes like structure and organic matter. Soils with roots growing deep and downward have the potential to feed a large and diverse population of soil life. These soil organisms can improve water-holding capacity, nutrient cycling, plant productivity, plant health, and nutrient density.

To evaluate, use a shovel to dig a hole in the pasture, large enough to see the indicator features.

If a comparison is needed or desired, locate one hole in a protected area, such as a fence line where grazing can occur, but soil is not adversely affected by hoof action, and the other within the pasture away from the protected area and on the same soil type to compare differences in soil features.

Soil features to observe and or to compare in the soil of each hole are —

- Ease of getting the shovel into the soil.
- Soil structure—look for platiness and aggregates in the top twelve inches.
- Rooting depth.

Compaction is one of the most detrimental resource concerns.

Healthy pasture soils should have good aggregates, vertical roots, and soil life.

- Root morphology and direction of growth—roots should be growing downward through the soil profile.
- Color—contrasting color changes in the soil with darker soil in the more biotically active upper layer.
- Worms, tunnels, or other biotic presence and activity.

When rating this indicator, begin with the primary subindicators (compaction layer, then root characteristics) and use these two subindicators as the main scoring factors, with the most adverse factor of the two subindicators determining the score. Soil color and soil life subindicators are secondary indicators and can be considered where applicable but used primarily for discussion with the manager and planning for improving soil health. When rating the compacted or platy layer, consider if the layer is within a zone where primary forage roots would typically extend to (not potentially).

Plant Vigor

In simplest terms, plant vigor refers to the health of a plant. Another interpretation is the plant's robustness in comparison to others of the same species, relative to the size and age of the plant within the environment and weather where it is growing. A loss of plant vigor can cause a loss in desirable species and plant cover. Primary things to consider when rating plant vigor are color and rate of regrowth (recovery) following a grazing event, but also taking into consideration the grazing height of plants, size (density) of plants, and productivity. This indicator is purposely placed as one of the last indicators to score doing this PCS. The scorer can then use the earlier indicator scores information to better score plant vigor.

Color is a major indicator of plant vigor. Yellowing plants indicate drought, insect damage, or prolonged heavy usage (continuous grazing). Pale green grass plants can be indicative of low fertility or cool, wet, and poor soils and growing conditions. Fields where nitrogen-starved grasses exist will be obvious and have dark green spots under dung or urine patches with the rest of the pasture area or unit being pale in comparison. Frost-damaged plants will turn yellow or to a blue gray cast depending on the severity of the cold damage.

Leaf color can also change due to age. Older, lower leaves of plants turn yellow as

Recovery and forage color are good indicators of plant health.

There are at least two types of erosion on this field. Circle both on the PCSS. The lowest rating score which accounts for the worst erosion present should be given.

they become more shaded and nutrients are translocated from them to the younger leaves higher in the canopy. This type of progressive vigor decline on a single plant is critical to the producer timing the rotation of livestock from one pasture to the next. In general, color is a visual indicator of either mineral deficiencies or, occasionally, of over-fertilization. Over-fertilization is not separated out in this indicator but should be annotated in the notes when observed and rated a 1 if an issue. Excess applications of nitrogen can cause some major nitrate toxicity issues. A lush, lodged, very dark green-to-bluish-green grass can be indicative of over-fertilization especially by nitrogen. It can also occur where livestock have concentrated on a pasture such as at a permanent water trough or feed bunk. These spot areas are often ungrazed by livestock due to taste, smell, or postingestive feedback caused by low level nitrate poisoning.

Growth rate is a key trait of plant vigor, which is greatly affected by the management of the plant community. Plant recovery should be evaluated based on average growth rates for the plant community involved at the time of the season being rated. This is easier to evaluate on rotational pastures, because the last time an individual plant was grazed is likely to be known.

Too often, the recovery period for the plants is too short. Ideally, when growth is slow, longer recovery is needed, and when growth is fast, shorter recovery is needed. Recovery is influenced by the time of year, the type of plants, and even manager goals, such as if it is planned to be used for stockpiled forage or not. It is highly influenced by how severely the pasture was used the last time it was grazed. The more severe the grazing (below recommended stop-grazing heights), the longer the recovery required. Most severe grazing occurs when a pasture is overstocked. Pasture plants when continuously grazed have little or no recovery. In contrast are pastures that are rarely grazed below stop-grazing heights and management is initiated at prime plant recovery and intake amounts. Make notes on any disease or insect stresses (pressure) on the plants. Using color as a plant vigor indicator may be difficult during a plant's dormant season. Under such conditions, use the ratings of all indicators along with overall plant health and remaining leaf area to assist in a vigor score.

Erosion

Soil erosion involves the detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity. The types of erosion evaluated for pasture condition score are below.

Sheet and Rill

Soil loss caused by water drop impact, drip splash from water dropping off plant leaves and stems onto bare soil, and a thin sheet of runoff water flowing across the soil surface. Sheet and rill erosion increases as cover decreases. Evidence of sheet erosion appears as small debris dams of plant residue that build up at obstructions or span between obstructions. Some soil aggregates or worm castings may also be washed into the debris' dams. Rills are small, incised channels in the soil that run parallel to each other downslope. When rills appear, serious soil loss is occurring. This erosion type includes most irrigation-induced erosion.

Streambank, Shoreline

When in pastures, channels or shorelines can have heightened erosion problems and loss of vegetative cover that typically grows on them. These accelerated damages can result from grazing animal traffic in or on them. Open channels may be intermittent or perennial flowing streams or dry washes. The factors that affect the extent of disturbance livestock cause to streambanks, shorelines, and their associated vegetation include—

- Livestock traffic patterns.
- Frequency, duration, and intensity of use.
- Attractiveness of these channels or banks as sunning, dusting, travel lanes, watering, grazing, or rubbing areas.
- Channel shape and steepness of banks.
- Water flow characteristics (frequency, depth, sediment load, velocity, and turbulence).
- Only consider erosion caused or influenced by livestock use.

Wind

Wind is the transport and deposition of soil from one location to another, occurring when heavier, windblown soil particles abrade, exposing soil and causing particles to become airborne. Deposition of the heavier soil particles occurs downwind of obstructions, such as fence lines, buildings, and vegetation. Often vegetative debris is windrowed against obstructions and in extreme cases soil will abrade and smother vegetation.

Gullies

Gullies are an advanced stage of water erosion, developing in situations where rill erosion has not been addressed. Concentrated, fast-moving water can cause gully expansion through both mass soil caving along sides and head-cutting upslope, creating deep channels in the ground. Both ephemeral and advanced classic gullies should be addressed under this subindicator.

Circle or mark all erosion types found within the planning unit. Rate the indicator with the score for overall erosion as the lowest scoring point value of the erosion types.

Resources

USDA NRCS. 2019. National Resources Inventory Grazing Land On-Site Data Collection, Handbook of Instructions, Chapter 13, Dry Weight Rank Method, Page 13-8. Iowa State University of Science and Technology. https://grazingland.cssm.iastate.edu/reference-materials.

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Pasture Condition Score Sheet

Operator:		Date:	
Evaluator:		Pasture ID:	
Soil(s), ESD(s) and or FSG(s):		Livestock type:	
Current Season's Precipitation (check one)	Above Normal	Normal	Below Normal
Seasonal Temperature Trend (check one)	Above Normal	Normal	Below Normal

Evaluate the site and rate each indicator based upon your observations. Scores for each indicator may range from 1 to 5. Sum the indicator scores to determine overall pasture condition score.

Indicator	1 Point	2 Points	3 Points	4 Points	5 Points	Score Points
Percent Desirable Plants* (Dry Weight for Livestock Type)	Desirable species <20% of stand.	Desirable species 20 – 40% of stand.	Desirable species 41 – 60% of stand.	Desirable species 61 – 80% of stand.	Desirable species exceed 80% of stand.	
Percent Legume by Dry Weight	<5% **OR** >50% bloating legumes.	5-10% legumes **OR** >40% bloating legume.	11-20% legumes.	21-30% legumes.	31-40% legumes. No grass loss; grass may be increasing.	
Live (includes dormant) Plant Cover	Less than 40% is live leaf canopy. Remaining is either dead standing material, or bare ground.	40-65% is live leaf canopy. Remaining is either dead standing material, or bare ground.	66-80% live leaf canopy. Remaining is either dead standing material, or bare ground.	81-95% live leaf canopy. Remaining is either dead standing material, or bare ground.	More than 95% live (non-dormant) leaf canopy. Remaining is either dead standing material, or bare ground.	
Plant Diversity by Dry Weight (*See footnote at bottom of page)	**Diversity:** Very low	**Diversity:** Low	**Diversity:** Moderate	**Diversity:** High	**Diversity:** Very high	
	<50% desirable species **OR** 1 dominant desirable species in 1 functional group **OR** No dominant desirable species and all minor species in each functional group totaling <15%	2 dominant desirable species in 1 functional group **OR** 2 functional groups each represented by minor species totaling ≥15%	3 dominant desirable species in 1 functional group **OR** 2-3 dominant desirable species in 2 functional groups **OR** 3 functional groups each represented by minor species totaling ≥15%	4 dominant desirable species in 2 functional groups **OR** 3 dominant desirable species in 3 functional groups **OR** 3 dominant desirable species in 2 functional groups **AND** 1 additional functional group represented by minor species totaling ≥15%	4 dominant desirable species in 3 functional groups **OR** 4 dominant desirable species in 2 functional groups **AND** 1 additional functional group represented by minor species totaling ≥15%	
Plant Residue and Litter as Soil Cover (Pull back canopy)	Bare soil is very easily seen;	Openings of bare soil can be seen fairly easily;	Small openings of bare soil can be seen, but minimal;	No bare soil is easily seen;	No bare soil is seen;	
	There is <20% cover on the soil surface or it is excessive, and slow to break down.	Soil cover is 21-40%.	Soil cover is 41-60%.	Soil cover is 61-80%.	Soil cover is >80% with good biological activity and decomposition of older residue.	
Grazing Utilization and Severity	Pasture is overgrazed throughout.	Pasture consists primarily of overgrazed and/or refused areas (former dung areas, older plants, undesired plants).	Pastures show uneven grazing throughout with heavier grazing near water or feeding areas, or distinct zone grazing.	Pasture grazed evenly throughout with minimal overgrazing with some under grazed small areas and heavier use near water sources.	Pasture grazed evenly throughout with no overgrazing.	

*Use NRCS plant list for livestock species. Functional groups are as appropriate for your state (cool-season grasses, legumes, warm-season grasses, non-leguminous forbs). Any time there are more undesirables than desirables, it will be 1 point. Desirable species must total more than 50% of the total biomass. Dominant species are ≥15%. Functional groups must be ≥15% of stand to be counted.

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Indicator	1 Point	2 Points	3 Points	4 Points	5 Points	Points
Livestock Concentration Areas (If field <1 acre, see ** footnote)	Livestock concentration areas are within 100 feet of, or are a direct conveyance to surface water, and cover more than 0.1 acre, including trails.	Livestock concentration areas are within 100 feet of, or are a direct conveyance to surface water, and cover less than 0.1 acre, including trails.	Livestock concentration areas are farther than 100 feet from and are not a direct conveyance to surface water, and cover more than 0.1 acre, including trails.	Livestock concentration areas are farther than 100 feet and are not a direct conveyance to surface water, and cover less than 0.1 acre, including trails.	Livestock concentration areas, including trails, not present.	
Soil Compaction and Soil Regenerative Features (***See footnote at bottom of page)	**Compaction:** Dense or thick platy layer very distinct;	**Compaction:** Dense or moderate platy layer noticeable;	**Compaction:** Thin dense or platy layer still present;	**Compaction:** Minor dense or platy layer; good aggregates common (crumbly soil);	**Compaction:** No dense or platy layers; crumbly soil throughout;	
	Roots: Dominantly horizontal; most shallow/sparse;	**Roots:** Numerous horizontal; moderate amount shallow/sparse;	**Roots:** Some horizontal with increasing downward;	**Roots:** Few horizontal, more downward through the soil profile;	**Roots:** Abundant growth primarily downward through the soil profile;	
	Color: Surface horizon same as subsoil;		**Color:** Surface horizon moderately darker than subsoil;		**Color:** Surface horizon dramatically darker than subsoil;	
	Soil Life: Few or no signs.	**Soil Life:** Signs scattered in surface layer.	**Soil Life:** Signs scattered throughout.	**Soil Life:** Signs numerous throughout.	**Soil Life:** Signs abundant throughout.	
Plant Vigor	No plant recovery after grazing/harvest. Pale, yellow or brown, or severe stunting of desirable forage.	Some recovery. Yellowish green forage, or moderately or slight stunting of desirable forage.	Adequate recovery of desirable forage. Yellowish and dark green areas due to manure and urine patches.	Good recovery of desirable forage. Light green and dark green forage present.	Rapid recovery of desirable forage. All healthy green forage.	
Erosion (Circle all that apply; the overall indicator score will be the lowest rating indicated)	**Sheet and Rill:** Plant density is insufficient to stop runoff, with poor infiltration. Erosion easily visible throughout pasture;	**Sheet and Rill:** Plant density slows runoff. Erosion present and easily seen on steeper terrain;	**Sheet and Rill:** Plant density good and runoff moderate. If present, erosion concentrated on heavily used areas;	**Sheet and Rill:** Plant density high, runoff low, good infiltration. May have evidence of past erosion if present;	**Sheet and Rill:** Plant density high, no runoff, good infiltration. No evidence of present or past erosion;	
	Wind: Severe scoured areas and deposition throughout;	**Wind:** Scoured areas common, deposition effecting plants;	**Wind:** Occasional scoured areas, litter windrolled;	**Wind:** Minimal soil exposed, some detatched vegetation windrolled, minor plant damage;	**Wind:** No exposed soil;	
	Streambank and/or Shoreline: Banks bare, major sloughing, no bank vegetation;	**Streambank and/or Shoreline:** More than half the bank vegetation trampled; sloughing.	**Streambank and/or Shoreline:** Less than half the bank vegetation trampled; eroding at crossing/entrances.	**Streambank and/or Shoreline:** Eroding at crossings, entrances; all the bank vegetation is intact and banks are stable.	**Streambank and/or Shoreline:** Vegetation intact and stable, hardened crossings and alternative water sources used;	
	Gully: Very large mass movement, caving sides.	**Gully:** Advancing upslope, increasing fingering extensions.	**Gully:** Not all active but extensions present.	**Gully:** Stable with vegetative cover.	**Gully:** None, drainage ways vegetative.	

** If field size is less than 1 ac. Use 10% of field size in place of 0.1 acre. ***Use a shovel. Root and Compaction subindicators are primary and should be considered first. Soil color and soil life are secondary subindicators which can be considered where applicable.

Overall Pasture Condition Score	Individual Indicator Score	Management Change Suggested
45 to 50	5	No changes in management needed at this time.
35 to 45	4	Minor changes would enhance, do most beneficial first.
25 to 35	3	Improvements would benefit productivity and/or environment.
15 to 25	2	Needs immediate management changes, high return likely.
10 to 15	1	Major effort required in time, management and expense.

Overall Pasture Condition Score =

Comments/Notes:

Item 13

Common Pasture Weeds and Grasses Guide

No Instructions

Item 14

Clipboard, Notebook and Pen

No Instructions

Item 15

Estimating Ground Cover

Making More From Sheep

Greg Lodge

Measuring groundcover is easy. Either visualise a 50 cm by 50 cm square or make one out of wire. Stand over this area, look directly down onto the pasture and estimate the amount of ground that is covered by plants, litter and dung. Even without any training you will be reasonably close to the right number and photos may help improve your estimate. For each paddock, record groundcover at about 30 random locations, look at the variation (highest and lowest values) and calculate the average.

You can also look for more visual signs of erosion and soil loss such as gullies, rills and tunnelling, washing of soil, dung and litter along fence lines and around plants, muddy and silted dams and muddy streams with high sediment loads. Monitor groundcover and grazing activity regularly to assess progress. You will be amazed how quickly you can make an impact. Be particularly careful in dry or drought periods. Select 'sacrifice' paddocks or construct containment areas for hand feeding, to retain groundcover or build it up in the rested paddocks over time.

Sampling Method

Take 30 random samples throughout the paddock and record the ground cover percentage in the quadrats.

To determine the average ground cover percentage of an area: add up all the percentage readings taken in the same area and divide that by 30 (the number of assessments taken)

Averaging the measurements in each area monitored will give you an overall ground cover percentage figure for that area only.

Instructions on ways to take samples using a quadrant are at www.mla.com.au/mbfp-tool22

Item 15

At 20% Groundcover

Run-off water loss = 160mm per year
Soil loss = 8.5mm per year
Poor plant production and sustainability
Low green leaf and plant vigour
Low water infiltration
Plants exposed to temperature extremes
Low litter
Low microbial activity
Poor organic matter content
Poor soil structure and surface sealing of soil

At 40% Groundcover

Still too low
Run-off water loss = 90mm per year
Soil loss = 4mm per year
Poor pasture and soil health

At 70% Groundcover

Run-off water loss = 10mm per year
Soil loss = 0.3mm per year
Good plant production and sustainability
High green leaf and plant vigour
High water infiltration

At 90% Groundcover

Reduced run-off water and soil loss
On slopes, groundcover should target 100% to retain top soil, nutrients and to promote stable pasture conditions
Weed colonization will be reduced when bare ground is removed

Item 15

At 100% Groundcover

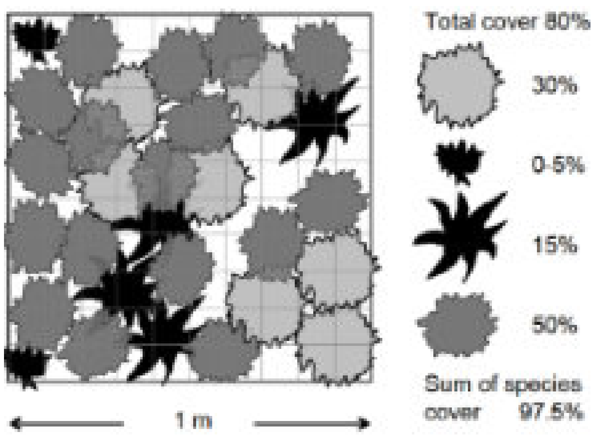

Figure 1: Illustration of a 1 m x 1 m sampling quadrat, showing estimates of total cover, individual species covers of four species (shown as different combinations of shape and colour), and sum of species cover. The sum of species cover is higher than total cover primarily because of between-species ov

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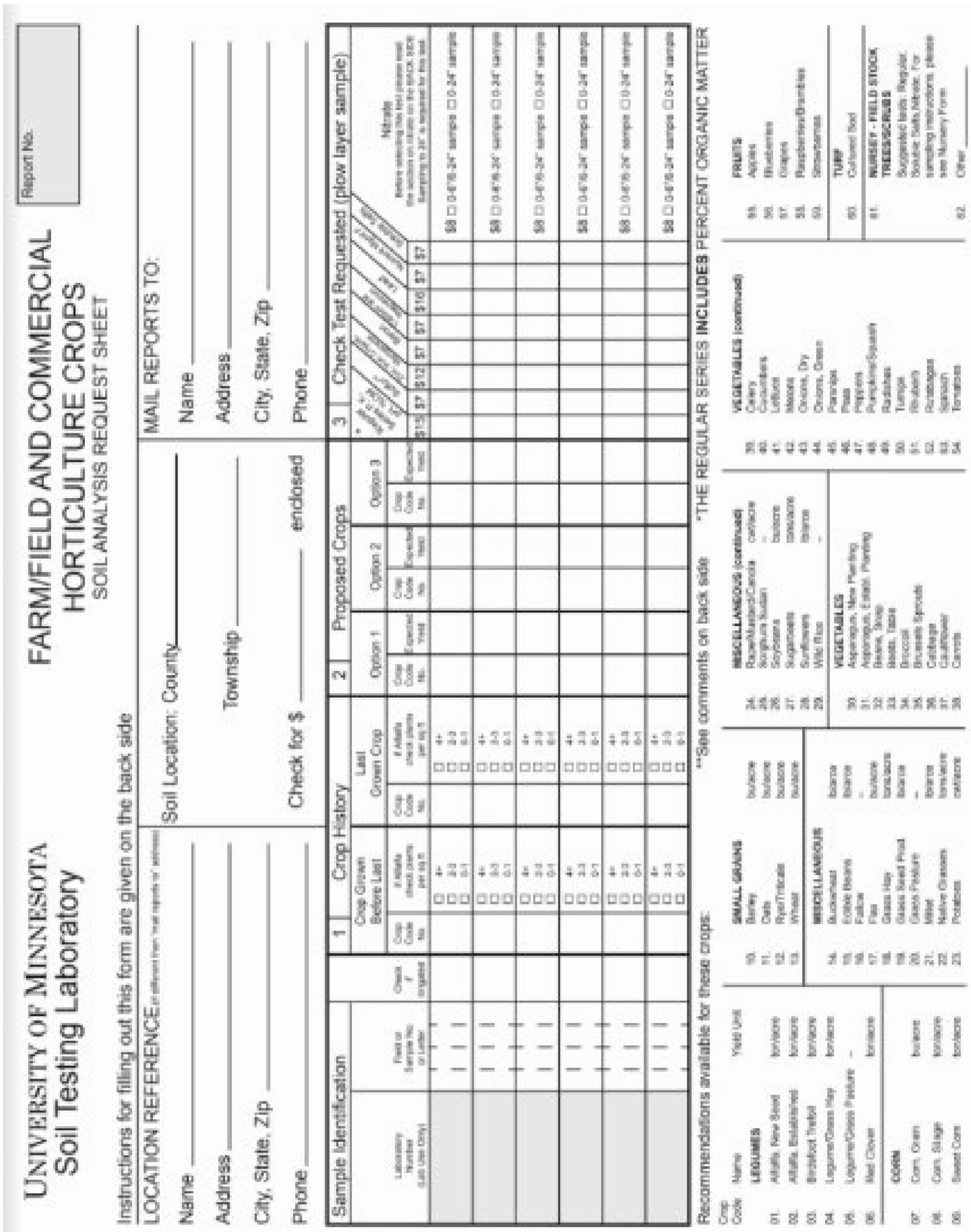
Item 16

Soil Probe

No Instructions

Item 17

Soil Analysis Request Sheet



INSTRUCTIONS FOR COMPLETING SOIL SAMPLE SUBMISSION FORM

Field History (1): This information is essential for us to provide the most accurate nitrogen recommendations possible. Indicate crops grown the past **two** growing seasons. BE SURE TO USE THE CROP CODE NUMBER FROM THE LISTING ON THE FRONT SIDE. If alfalfa was the crop grown during either or both of the two previous growing seasons, it is important to indicate the number of plants (crowns) per sq. ft.

Proposed Crops and Yield Goals (2): You can select recommendations for up to **three crops** by entering the corresponding crop code number, **or three yield goals** for one crop. At least one option must be completed to receive a fertilizer recommendation. If alfalfa is planned for the following year, list the crop code 01 under Option 2 or Option 3 with the desired yield in order to get a lime recommendation to reach pH 6.5. For CRP acres, list the crop most similar to that being seeded (e.g., 04 for legume/grass hay, or 22 for native grasses.)

Tests Requested (3): Indicate test choices for each sample. Cost for each test is shown. **Before selecting nitrate, read the information below for Nitrate Test** to see if it applies to your area or crop.

- **Regular Series:** Sample the plow layer (6-8 inches) for cultivated land, or to 3 inches for pastures or sod fields. Includes phosphorus, potassium, pH - lime requirement, percent organic matter, estimated texture.
- **Special Tests:** These tests are conducted only on the plowlayer depth. Includes zinc, copper, iron, manganese, boron, calcium, magnesium, soluble salts (electrical conductivity). (Copper recommendations apply only for peat or muck soils.) Research has shown that for Minnesota soils, tests for iron and manganese are not practical; they are included to accommodate special requests.
- **Sulfur Test:** The sulfur test is not a reliable predictor of sulfur needs. Sulfur recommendations are based on crop and soil texture. See your county extension educator for details.
- **Nutrient Management P Test:** This test is an Olsen extractable P test, but is designed for situations where the soil test level for phosphorus is expected to be in the high range (>50 ppm Olsen) and is required for nutrient management decisions. Range is 20 – 250 ppm extractable Olsen P.
- **Nitrate Test:** For the N recommendation to be based on the nitrate value, **the soil MUST be collected to a depth of 24 inches.** There are two options: 1) submit two separate samples, a 0-6" depth and a 6"-24" depth sample; 2) collect the soil from 0-24" for the nitrate test only. The nitrate test applies to non-sandy soils in western Minnesota with an exception noted below. This test is preferred for making N recommendations for the counties west of and including Lake of the Woods, Beltrami, Becker, Otter Tail, Douglas, Pope, Kandiyohi, Renville, Redwood, Cottonwood, and Jackson. In these counties, the nitrate test is used in making N recommendations for corn, small grains, potatoes, and sugar beets.
  For the counties EAST of those cited, the nitrate test is used to recommend N only if the sample is collected in the spring before or near planting (April 1 – June 15).
  N fertilizer recommendations will not be based on the analysis of only plow layer samples for nitrate-nitrogen. If only a plow layer sample is submitted, N recommendations will be based on cropping history, intended crop, yield goal, and soil organic matter level.
  Samples collected for the nitrate test should be **frozen or air-dried immediately**. Drying can be accomplished by spreading the soil in the sun, or placing near a heat source. If only nitrate is to be determined, the samples can be dried in a microwave oven using several 2-minute power cycles, stirring between each cycle. Please use an insulated container for shipping frozen samples, as premature thawing can affect nitrate test results.

SAMPLING INSTRUCTIONS

Submit one sample for each area of the field. Each area should have fairly uniform soil color and texture, cropping history, fertilizer, lime, and manure treatments. One sample should not represent more than **20 acres** on level, uniform landscapes, or **5 acres** on hilly or rolling land. Within each area collect 15-30 sub-samples (cores, borings, or spade slices) in a grid pattern. The more variable the soil, the more sub-samples should be combined per area sampled. Mix the sub-samples thoroughly in a clean plastic pail, and fill the sample box or bag to the fill line (1 pint). **If samples must be taken wet, they should be dried before being mixed and submitted to the laboratory.** Do not exceed a drying temperature of 97°F, and do not use a microwave oven unless only the nitrate test is requested.

Sample each area as follows: Scrape off all surface residue. Sample to the plow layer for cultivated crops or 3 inches for pasture or sod fields. Sample row crop fields between rows, except for ridge-till plantings. Where ridge-till is used, take the sample to a depth of 6-8 inches on the shoulder of the ridge, avoiding the starter fertilizer band. Avoid sampling dead or back furrows, terraces, old fence rows, lime or fertilizer spill areas, headlands, eroded knolls, low spots, or small saline areas. Sample at least 300 feet away from gravel or crushed limestone roads because their dust changes soil pH.

SHIPPING INSTRUCTIONS

Fill out the information sheet as completely as possible so that accurate recommendations can be given. Keep a copy for your records. Place samples in a shipping carton and **enclose the information sheet with a check made payable to The University of Minnesota**. Please do not send cash. The lab is not responsible for cash payment by mail. If the shipping carton is a re-used box, wrap in heavy brown paper.

Ship samples to:

Soil Testing Laboratory
University of Minnesota
135 Crops Research Building
1902 Dudley Avenue
St. Paul, MN 55108

For additional information on soil analyses, please see our website: http://soiltest.cfans.umn.edu, or call or visit your local county extension office. You may also call the Landscape Arboretum Yard and Garden line at (952) 443-1426, or the Soil Testing Laboratory at (612) 625-3101.

Diagnosing Soil Compaction Using a Penetrometer (Soil Compaction Tester)

Penn State Extension

Sjoerd W. Duiker

The Rationale for the Penetrometer

Soil compaction is a serious concern for farmers in Pennsylvania. Soil compaction can easily reduce crop yields by 10 percent, and can lead to water and soil quality degradation due to increased runoff and soil structure destruction. The continuous consolidation of farms means that herds are growing, more forage is harvested per farm, more manure is being produced, larger equipment is used to spread manure and harvest and transport forages and grain, and the opportunity to tailor field operations to optimum soil conditions for traffic is decreasing. Compaction is therefore an issue that will likely increase in importance in the years to come.

There are two forms of compaction: surface and sub surface. While surface compaction can be partly alleviated with normal tillage operations, subsurface compaction below the normal tillage depth will remain. Fracturing or cutting subsurface compacted soil has, in some cases, resulted in remarkable yield increases. Many Pennsylvania producers suspect they have a subsurface compaction problem, but have no handle on how to measure it. A diagnostic tool to measure the extent and depth of subsurface compaction is a penetrometer, or soil compaction tester. This tool can help producers determine if subsoiling might be beneficial and at what depth the subsoiler should be set. Several companies sell penetrometers that are all based on the same technical specifications of the American Society of Agricultural Engineers. A penetrometer will cost around $200.

A penetrometer consists of a 30-degree circular stain less steel cone with a driving shaft and a pressure gauge (Figures 1a and 1b). The penetrometer usually comes with two cones, one with a base diameter of 0.798 (¾) inch for soft soils and the other with a base diameter of 0.505 (½) inch for hard soils. The tip is slightly wider than the driving shaft to limit friction of the shaft with the soil. The driving shaft is usually graduated every 3 inches to allow the determination of depth of compaction. The pressure gauge indicates pressure in pounds per square inch (be sure to use the appropriate scale for the tip you are using).

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Figure 1a. A penetrometer, or soil compaction tester, has a graded shaft and separate reading scales for each tip. (Figure courtesy of Dickey John)

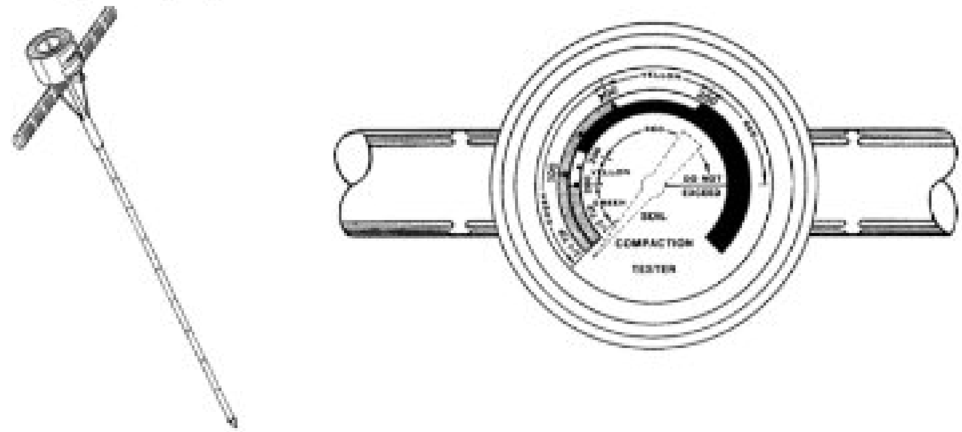
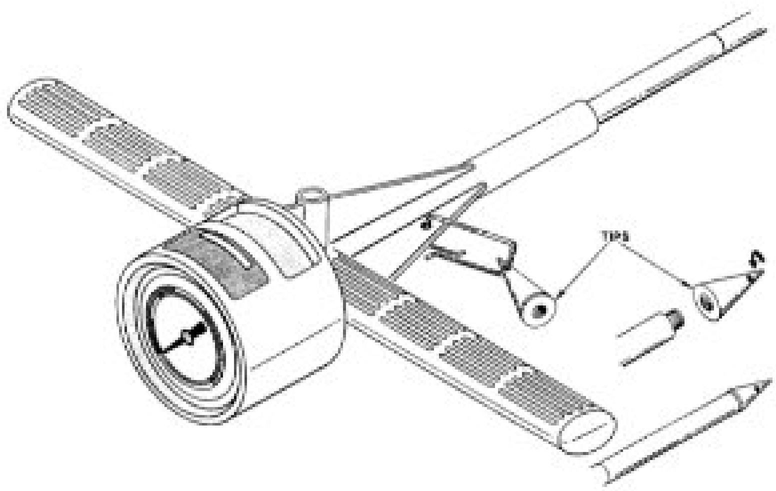
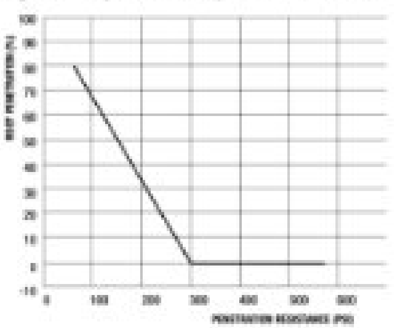


Figure 1b. A penetrometer usually comes with two points (½ and ¾ inch diameter). (Figure courtesy of Dickey John)



The penetrometer is designed to mimic a plant root. Of course, a plant root is living, and much smaller than a penetrometer, so the penetrometer can be expected to have some shortcomings. In studies conducted at the United States Department of Agriculture's Agricultural Research Service (USDA-ARS), root penetration into soil cores packed to different densities was measured and compared to penetrometer readings. Root penetration decreases linearly with penetration resistance, until almost no roots penetrate into soil with a penetration resistance of 300 psi (Figure 2). Much of this research was done with cotton, but it also appears to hold true for other crops. Although the limit of zero root growth may not be exactly at 300 psi, it is certain that root growth will be greatly inhibited at higher penetrometer readings. This is true in both wet and dry soils, and is independent of soil texture. Unfortunately, the penetrometer does not capture pores created by physical or biological forces such as freezing/thawing, wetting/drying, earthworm burrowing, and root channeling. Plant roots will find and grow through these spaces in the soil if they are present.

Figure 2. Root penetration and penetration resistance.



The penetrometer simulates root growth. Root growth decreases linearly with increasing penetration resistance, until practically stopping above 300 psi. Remember, however, that roots may still penetrate soil with a penetration resistance greater than 300 psi if natural cracks and pores are present.

How to Use the Penetrometer

The readings taken with the penetrometer are called the cone index. The readings should be taken when the whole profile is at field capacity (approximately 24 hours after a soaking rain). The best time of the year for the compaction measurement is the spring because the whole profile has usually been thoroughly moistened during the winter. If the soil is too wet (muddy), compaction could be underestimated because the soil acts as a liquid. If the soil is too dry, compaction could be overestimated because roots will be able to penetrate the soil when it dampens. The idea behind using the penetrometer at field capacity is that this is the best-case scenario for roots. Hopefully, the soil will be at field capacity at various times during the growing season. During these periods, roots will be able to penetrate soil that has low penetration resistance. Penetration resistance will increase when the soil dries out, and root growth can then be expected to be limited. However, when the moisture content of the soil increases again, penetration resistance will decrease, and root growth will resume.

The penetrometer rod should be driven in the soil at a rate of approximately one inch per second. As you push the penetrometer into the soil, record the depth at which the 300 psi level is exceeded, using the gradients on the penetrometer rod. This level is the top of the compacted zone. Continue pressing the penetrometer down. Record the depth at which the penetration falls below 300 psi. This is the bottom of the compacted zone. For each measuring point, there are two numbers: the top of the compaction zone and the bottom of the compaction zone. If penetration resistance never increases above 300 psi, you will have blanks in both spaces, indicating no severe root-limiting compaction. If the penetration resistance increases above 300 psi, but never falls below 300 psi, there is no bottom to the compaction zone.

Cone index should be measured respective to tillage relief, wheel tracks, plant rows, and other recognizable patterns in the field. For example, if you know the areas of wheel traffic, take transects in and out of the track, and report them separately. If there are subsoiled zones in the field, measure penetration resistance in and out of the subsoiled zone. If there are planted rows, take measurements in

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Table 1. Interpretation of penetration resistance measurements.		
PERCENTAGE OF MEASURING POINTS HAVING CONE INDEX > 300 PSI IN TOP 15 INCHES	COMPACTION RATING	SUBSOILING RECOMMENDED
< 30	Little to none	No
30–50	Slight	No
50–75	Moderate	Yes
>75	Severe	Yes

Adapted from: Lloyd Murdock, Tim Gray, Freddie Higgins, and Ken Wells, 1995. *Soil Compaction in Kentucky*. Cooperative Extension Service, University of Kentucky, AGR-161.

and between the rows, and report them separately. Take separate readings for trafficked and nontrafficked areas.

The number of readings in a field depends on the accuracy you desire. As a first approximation, take some preliminary readings at a few places in the field to develop a sampling strategy. The cone index values are likely to be quite variable, so multiple readings are required per field. It is recommended to take one reading every 100 to 150 feet, or three to four readings per acre to develop a solid recommendation. This is a useful spacing if no recognizable pat terns are present. If you recognize patterns, you may wish to increase the number of readings and report them separately as suggested above. It is extremely useful to compare the cone index values in the field with measurements in undisturbed areas such as fence rows.

After completing the sampling, a recommendation can be formulated using Table 1.

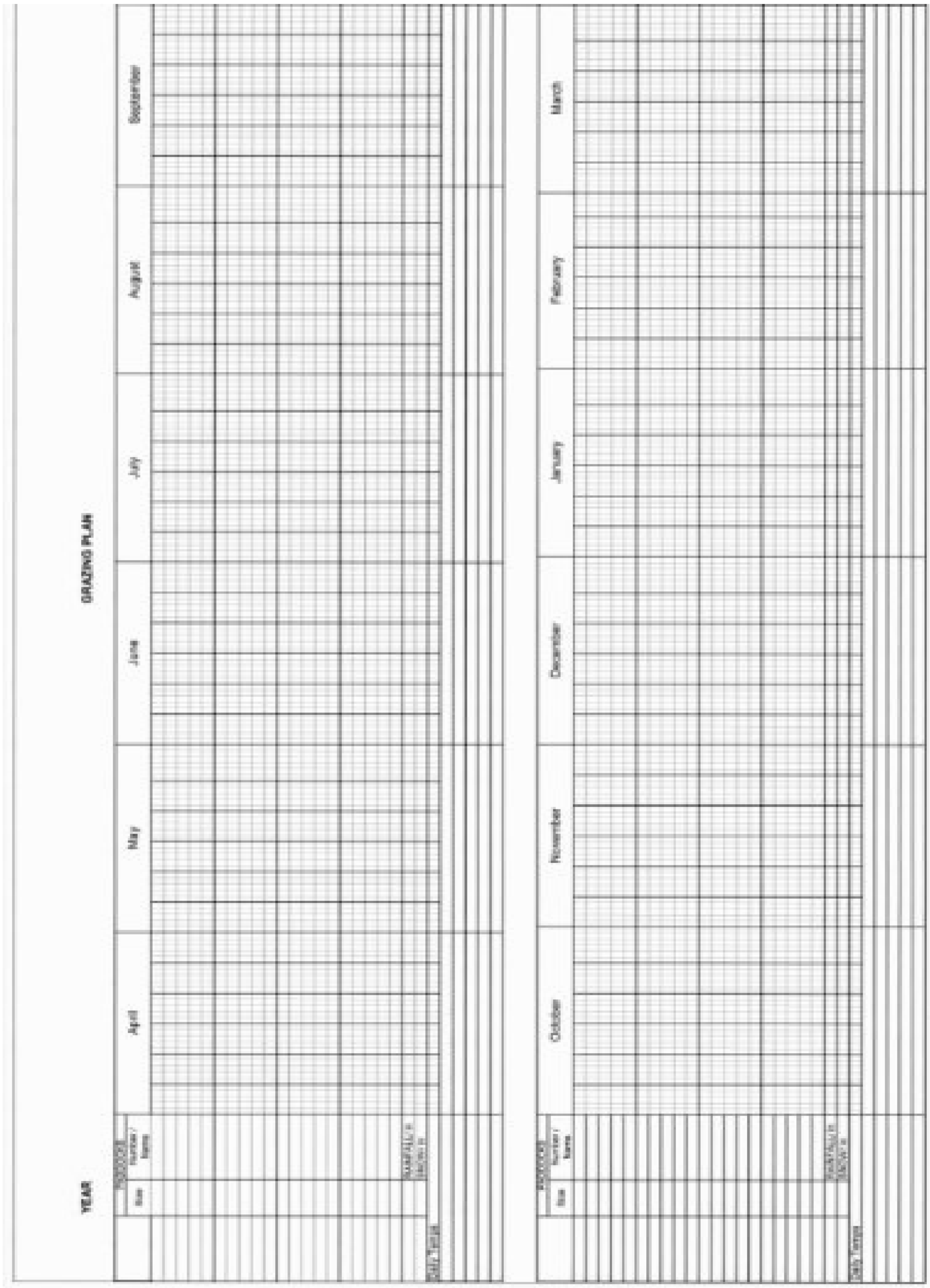
The measurement of the lower boundary of the compaction zone determines the depth of subsoiling. If subsoiling is recommended, run the subsoiler 1 inch below the compaction zone. Setting the subsoiler much deeper will not provide additional benefits. If subsoiling is done, it is important to eliminate the cause of compaction to avoid recompaction. Subsoiling should only be considered to be a measure of last resort, not an annual management practice. These recommendations are based on research conducted at the University of Kentucky. With time, we hope to validate them in Pennsylvania.

Original Article Link:

https://extension.psu.edu/diagnosing-soil-compaction-using-a-penetrometer-soil-compaction-tester

Item 19

NRCS Grazing Record Keeping Chart



NRCS Determining Forage Production

Lance Smith

Needed Equipment

Determining a Representative Area

% DESIREABLE SPECIES
% UNDESIREABLE SPECIES
% TOXIC SPECIES
SPECIES MATURITY

Representative Number of Samples

LANDSCAPE POSITIONS
SPECIES COMPOSITION

Item 20

Visual Estimation

SPECIES COMPOSITION LIST

A LIST OF PLANT SPECIES WILL HELP DETERMINE THE CURRENT DESIREABILITY OF THE PLANTS WITH THE LIVESTOCK SPECIES OF CONCERN

IT WILL ALSO GIVE A BASELINE FOR DETERMINING FORAGE PLANT COMPOSITION TREND (+ OR -) IN THE FUTURE

#/ACRE OF 100% DRY MATTER-DM

SPECIES COMPOSITION AS A % OF THE TOTAL

Total Annual Forage Production Worksheet

Total Annual Forage Production Worksheet

Cooperator: ______________________ Date: ______________________

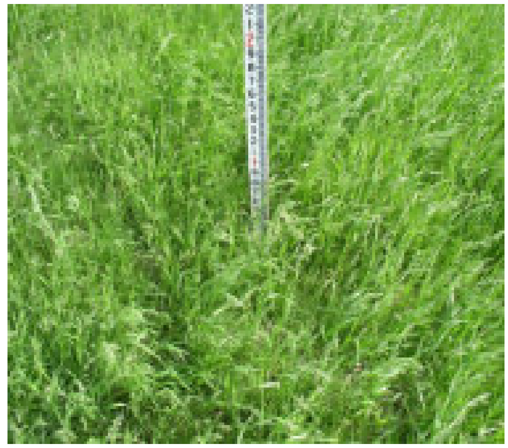
Conservationist: ______________________

A Pasture # OR Species Name	B Green Weight Pounds	C Percent Dry Weight 1/	D Percent Growth Ungrazed 1/	E Percent Growth Completed 1/	F Percent Of Normal Production 1/	G Reconstruction Factor C/D x E x F	H Percent Useable Forage	I Reconstructed Present Weight B x G x H
EXAMPLE #1								
Existing CRP - Native Warm	4600	75	100	100	100	.75	50	1725
EXAMPLE #2								
Previous Year Mgt. - Mixed Grass	2400	20	100	40	100	.5	90	1080
Total present reconstructed weight								

Comments: ______________________

Item 20

Visual Estimation



FORAGE HEIGHT
LOOK OUT
TAKE PHOTO

STAND DENSITY
LOOK DOWN
TAKE PHOTO

HOW MANY #/ACRE OF 100% DM DO YOU ESTIMATE?

Hoop, Scale, and Field Math

HOOP SIZES

0.96 FT/SQ = 41.68” CIRCUMFERENCE

1.92 FT/SQ = 58.94” CIRCUMFERENCE

GRAM SCALES

100 GM SPRING SCALE

600 GM SPRING SCALE

FIELD MATH

(0.96) GM X 100 = #/ACRE

(1.92) GM X 50 = #/ACRE

Positioning the Hoop

IN IS IN

OUT IS OUT

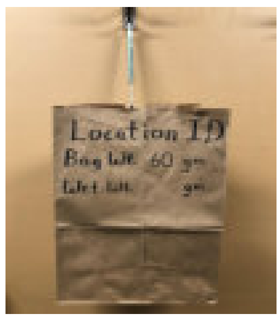
Item 20

Clipping

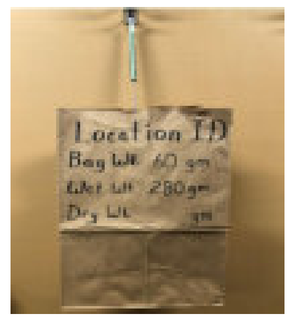
WHAT TO CLIP
WHAT NOT TO CLIP
CLIPPING OPTIONS
ALL FORAGE
LEAVE RESIDUAL

Weighing Sample - Field

RECORD BAG WEIGHT



RECORD WET WEIGHT

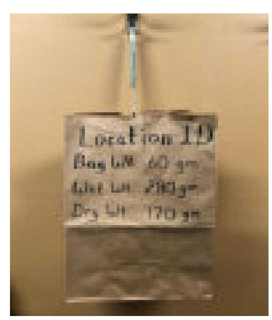


Drying Sample

BROWN PAPER BAG
OPEN TOP
MIX DAILY
AIR DRY 3-5 DAYS
    UNTIL CRUNCHY
    MICROWAVE OPTION
100% DM

Weighing Sample - Office

RECORD DRY WEIGHT



Item 20

Calculations

TOTAL (100% DM) #/ACRE

TOTAL DRY WEIGHT – BAG WEIGHT = NET WEIGHT

NET WEIGHT X CONVERSION FACTOR (50 OR 100) = TOTAL #/ACRE 100% DM

TOTAL #/ACRE – PLANNED RESIDUAL #/ACRE = #/ACRE AVAIABLE FORAGE

% MOISTURE

NET WEIGHT DRY / NET WEIGHT WET = % DM

100% - % DM = % MOISTURE

TOTAL (100% DM) #/ACRE

TOTAL DRY WEIGHT – BAG WEIGHT = NET WEIGHT

170 gm – 60 gm = 110 gm

NET WEIGHT X CONVERSION FACTOR (50 OR 100) = TOTAL #/ACRE 100% DM

110 gm X 50 = 5,500 #DM/ACRE

% MOISTURE

NET WEIGHT DRY / NET WEIGHT WET = % DM

170 gm – 60 gm = 110 gm

280 gm – 60 gm = 220 gm

110 gm / 220 gm = 50% DM

100% - % DM = % MOISTURE

100% - 50% = 50% MOISTURE

% MOISTURE

NET WEIGHT DRY / NET WEIGHT WET = % DM

170 gm – 60 gm = 110 gm X 50 = 5,500#

280 gm – 60 gm = 220 gm X 50 = 11,000#

5,500# / 11,000# = 50% DM

100% - % DM = % MOISTURE

100% - 50% = 50% MOISTURE

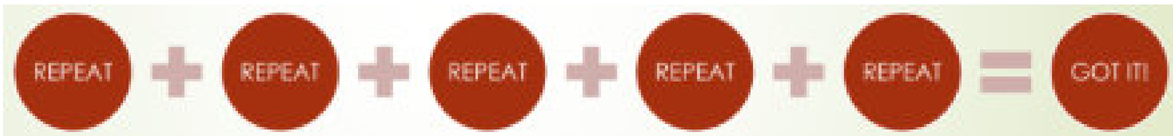
Grasses	Before heading; initial growth to boot stage (%)	Headed out; boot stage to flowering (%)	Seed ripe; leaf tips drying (%)	Leaves dry; stems partly dry (%)	Apparent dormancy (%)
Cool season	35	45	60	85	95
wheatgrasses					
perennial bromes					
bluegrasses					
prairie junegrass					
Warm season					
Tall grasses	30	45	60	85	95
bluestems					
indiangrass					
switchgrass					
Midgrasses	40	55	65	90	95
side-oats grama					
tobosa					
galleta					
Short grasses	45	60	80	90	95
blue grama					
buffalograss					
short three-awns					

Item 20

Estimated vs Calculated

Adjustment Up? Adjustment Down?

Repeat



Forage Utilization

THIS IS THE EASY PART

TOTAL HERD WEIGHT X 4% = TOTAL POUNDS FORAGE REQUIRED/DAY
TOTAL POUNDS FORAGE/DAY X # OF DAYS = TOTAL POUNDS REQUIRED
GRAZING SEASON
GRAZING PERIOD

TOTAL HERD WEIGHT X 2% = TOTAL GALLONS OF WATER REQUIRED/DAY

Lance Smith
MN State Rangeland Management Specialist

2830K1 Double Ring Infiltrometer Kit Operating Instructions

SoilMoisture Equipment Corp.

On These Operating Instructions

☞ If the text follows a mark (as shown on the left), this means that an important instruction follows.

! If the text follows a mark (as shown on the left), this means that an important warning follows relating to danger to the user or damage to the apparatus.The user is always responsible for its own personal protection.

Text Italic indicated text indicates that the text concerned appears in writing on the display or the apparatus (or must be typed).

Introduction

The double ring infiltrometer is a simple instrument used for determining water infiltration of the soil (Measurements according to ASTM D3385-03 standard test method and DIN 19682 page 7). The rings are partially inserted into the soil and filled with water, after which the speed of infiltration is measured. The double ring limits the lateral spread of water after infiltration.

The standard set consists of three pairs of inner and outer rings, allowing synchronic measuring. This saves time and produces reliable average data.

Infiltration is the process of water penetrating the ground surface. The intensity of this process is called the infiltration rate. The infiltration rate is expressed in terms of the volume of water per ground surface and per unit of time [L/T, for instance mm/min]. The infiltration capacity of the soil indicates the maximum infiltration rate at a certain moment. Under certain circumstances, it may be necessary to determine the infiltration capacity of the soil, for instance in infiltration areas or infiltration basins.

The double ring infiltrometer is suitable for almost any type of soil and is applied in irrigation and drainage projects, groundwater and infiltration basins, in optimising water availability for plants and to determine the effects of cultivation.

Soil Water

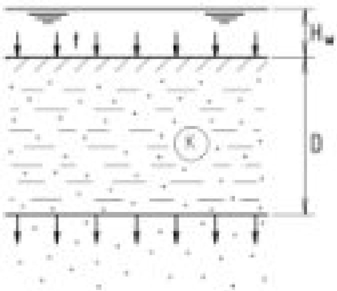
Soil Water Energy

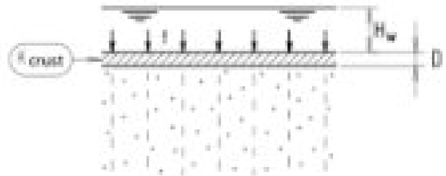
Soil water is subjected to forces caused by gravity, capillarity, adsorption and osmosis. Capillary forces and osmosis in conjunction act as matrix force to the soil water (osmotic forces, in particular in areas low in salt, are negligible).

The soil water energy is expressed in terms of potential energy or potential. The soil water potential is made up of the gravitational potential and the pressure potential (comprising a negative pressure or “suction” in the unsaturated zone and a positive pressure in the saturated zone). Under the influence of the potential differences, water flows in a certain direction at a certain speed. The rate of flow also depends on the hydraulic conductivity of the soil.

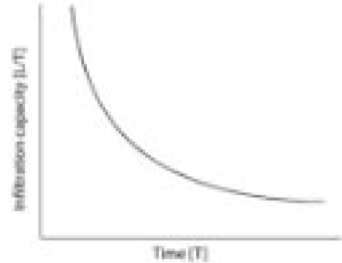
The hydraulic conductivity [L/T] varies with moisture content of the soil: the dryer the soil, the lower the level of hydraulic conductivity; soil pores filled with air do not conduct water. Saturated soil has the highest level of hydraulic conductivity (saturated hydraulic conductivity). This hydraulic conductivity is mainly determined by the geometry and the distribution of pores.

Item 21





Infiltration in homogeneous soil (left) and in crusted soil (right).



Infiltration

Water infiltrates the soil during a shower or irrigation. If moistening exceeds the infiltration capacity, water ponds the ground surface. In that case, the infiltration rate equals the infiltration capacity. This will cause in homogeneous soils a saturated top layer, with below a near-saturated zone which will expand by wetting of the underlying soil.

The theory of Green & Ampt (1911) describes the process of infiltration. The theory is derived from Darcy's Law, formulated as:

$$f = K (Hw + D - Hf) /D$$

where (see figure above): f refers to the infiltration capacity [L/T], K to the near-saturated hydraulic conductivity [L/T], Hw is the thickness of the water layer [L], D refers to the depth of the wetting front [L] and Hf refers to the pressure head at the wetting front [L].

The infiltration capacity of a soil decreases rapidly over time during infiltration. The course of infiltration capacity in time is expressed in terms of the infiltration curve (see figure).

The initial infiltration capacity in dry grounds is high, which is caused by a large matrix suction of the soil. In the near-saturated zone, potential differences are less; the water content hardly causes any variance in matrix suction. Consequently, the infiltration capacity decreases usually within a couple of hours until it reaches a constant value almost equaling the saturated hydraulic conductivity (the enclosure of air bubbles during infiltration prevents maximum saturation).

Some factors affecting the infiltration capacity at the soil surface are: soil compaction caused by ruts and treading, washing of fine particles into surface pores, and cracks and fissures (macro pores). These factors may lead to crusted soils. In addition, the vegetation and soil cultivation may affect infiltration capacity. The thickness of the ponded water layer will only affect the onset of infiltration.

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Soil type	Constant infiltration rate (mm/h)
Sand	> 30
Sandy loam	20 - 30
Loam	10 - 20
Clayey loam	5 - 10
Clay	1 - 5

See Bouwer (1986), ILRI (1974), Ward & Robinson (1990) for further information concerning soil water, infiltration and the use of the double ring infiltrometer.

The downward speed of infiltrating water depends on the texture, the structure and stratification (heterogeneity) of the soil, the soil moisture content and the groundwater level. A high groundwater level will cause stagnation of infiltrating water and the infiltration capacity will decrease, approaching zero.

A heterogeneous soil is often perceived as a succession of single, homogeneous soil layers. In a heterogeneous soil with downward decreasing permeability, the infiltration capacity equals the weighted average infiltration rate of the separate layers. A heterogeneous soil with downward increasing permeability, for example a crusted soil, will at a certain stage no longer be saturated (see figure above). The infiltration capacity will be affected if this occurs in a near-surface soil layer.

Some examples of constant infiltration rates (or near-saturated hydraulic conductivity) for different soil types are listed in the table.

Description

The standard double ring infiltrometer set consists of three pairs of inner and outer rings, a driving plate, an impact absorbing hammer, measuring bridges and measuring rods with floats.

The pairs of stainless steel infiltration rings have the following diameters: 28/53 cm, 30/55 cm and 32/57 cm. The ring's height is 25 cm and it has one cutting edge (after DIN 19682-7). The purpose of the outer ring is to have the infiltrating water act as a buffer zone against infiltrating water straining away sideways from the inner ring (this applies in particular for heterogeneous soils). Steel pull-out hooks allow removal of the rings. The varying diameters make them easy to stow and transport.

Each inner ring has a synthetic measuring bridge (3), the measuring rod (1) with float (4) moves freely up and down through a small tube (2) in the measuring bridge (see figure). The measuring rod indicates the water level. The float is positioned in the middle of the inner ring. As the measuring rod moves freely through the tube, the wind hardly affects measuring. The measuring rods have a millimeter calibration.

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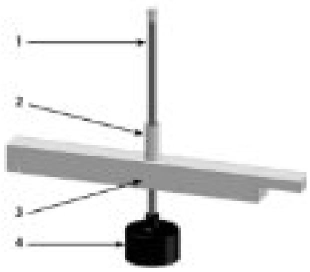


The galvanized steel driving plate is cross-shaped with a beating head in the middle. It is used for hammering in the 28 - 57 cm infiltration rings. Pins located at the bottom of the ring ensure proper placement and allows the outer ring to be centrically positioned. The shape of the driving plate spreads the effect of the hammering and does not damage the rim. This also ensures undisturbed insertion into the soil.

The steel hammer is impact-absorbing; its head contains lead bullets flowing in the direction of the stroke upon impact. Its nylon cups prevent damage to the driving plate.

The use of the double ring infiltrometer

Installation

1. Place the inner ring with the cutting edge facing down on the ground. Remove small obstacles such as stones or twigs. When measuring below the ground surface, a profiled pit should be made.

2. Put the driving plate on top of the inner ring. Depending on its diameter the ring will fit over, between or within the pins located on the bottom side of the driving plate.

3. Use the impact-absorbing hammer to insert the infiltration ring about 5 cm vertically into the soil. Make sure to disturb the soil as little as possible. In stiff soils have someone stand on the driving plate while another person drives it in. Remove the driving plate from the inserted infiltration ring.

☞ Keep the depth of placement as limited as possible so as not to disturb the top layer. Insert the rings in any case to below a particular top layer, such as a disturbed or crusted top layer or layer with macro-pores.

☞ In the case you should encounter any play between the ring and the ground, push the ring back in its place. A disturbed crust can be healed using bentonite or other soil material.

4. Place the outer ring with the cutting edge facing down around the inner ring and put the driving plate on top of it.

5. Repeat step 3. (see figure). The shape of the driving plate will ensure a depth

identical to that of the inner ring.

6. The standard double ring infiltrometer set allows simultaneous measuring in threefold. Place the rings 2 - 10 m apart, depending on the field situation, and repeat steps 1 to 5.

☞ Place all rings at a similar depth to allow comparison of the results. Differing ring diameters are not supposed to produce differing results

7. Place the measuring bridge with measuring rod and float on the inner ring. Remove, without disturbing the soil structure, any vegetation that may hamper free movement of the float or affect the measuring.

8. Fill the outer ring with water, then the inner ring, to approximately 5 - 10 cm. Start measuring immediately to determine the infiltration curve (see paragraph 3.2).

☞ The water level within the infiltration rings should be as low as possible to ensure vertical infiltration. The rings should not go dry. It is recommended to fill to 5 - 10 cm.

☞ To protect the ground surface when pouring the water, use plastic foil, a jute cloth, sponge or a 1 - 2 cm layer of sand or gravel. It is also possible to pour the water via your hand on the ground.

☞ Make sure to have sufficient water at hand. Filling one set of rings requires approx. 25 litre

Some Remarks:

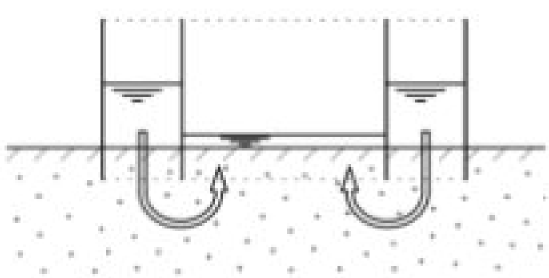
To measure only the infiltration capacity of saturated soil it will suffice to saturate the soil (by pouring water in the rings) without measuring.

To obtain optimal results in determining the infiltration capacity, use water of a similar quality and temperature to that of the real system you are examining.

Measuring

1. Start the measuring by noting the time and the water level in the inner ring (reference level) as indicated on the measuring rod. Use columns A and B on the field list. When carrying out synchronic measuring, use several field lists.

☞ Always use copies of the field list; use the original only for reproduction.



Decreasing infiltration caused by different water levels in the inner and the outer rings.

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2. Determine the drop in the water level in the inner ring during a certain interval. Note the time and the water level in column A and B on the field list. Start with short intervals (for instance 1-2 min) and conclude measuring with a longer interval (20 - 30 min, depending on the type of soil).

☞ Make sure the infiltration rings do not go dry during measuring. Add water when only a few centimetres of water are left in the rings. Write the new levels in column B of the list.

☞ Keep the water in the inner and outer ring at a similar level. A higher water level in the outer ring will lead to a decreasing infiltration rate in the inner ring. A lower water level in the inner ring will cause the buffering against lateral spreading to decrease.

3. Stop measuring only if the infiltration rate has reached a constant value. A change of < 10% in a certain phase is often considered as constant. Depending on the type of soil this may occur within 1 or 2 hours, in exceptional cases only after a day.

4. Remove the rings using the pull-out hooks.

5. Rinse the rings, make sure no earth sticks and sets to the rings. Proper maintenance will prevent unnecessary disturbance of the soil upon installation.

Computation of the Measuring Data

1. Calculate the cumulative time and time steps in columns C and D using the data in columns A and B. Determine the infiltration in column E by calculating the water level differences between intervals in column B.

2. Calculate the infiltration capacity (mm/min) in column F by dividing for each interval the infiltration (column E) by the time step (column D). If necessary, convert the infiltration capacity to e.g. [m/hour] in column G.

3. The tabulated data can be used to determine the infiltration curve. Plot out the calculated infiltration capacity (column F or G) on the y-axis of a graph and the cumulative time (column C) on the x-axis.

4. The near-saturated hydraulic conductivity equals the more or less constant infiltration capacity established toward conclusion of the measuring. Use multiple measurements to calculate a reliable mean value for a certain type of soil or landscape unit.

5. Determine, if necessary, the cumulative infiltration for a certain period. The cumulative infiltration is the total amount of water infiltrating over a certain period of time (L, for instance mm). Fill in column H of the field list by adding the total infiltration (column E) for each interval from the starting of measuring on.

Applications

The double ring infiltrometer is suitable for almost any type of soil with the exception of clogging soils, stony soils or the soil of steep slopes. The outer ring causes almost vertical infiltration of water from the inner ring. A number of soil hydrological features can be determined (per soil layer):

Infiltration capacity.

Near-saturated hydraulic conductivity.

Infiltration curve.

Cumulative infiltration over a certain period.

The double ring infiltrometer is applied, among other things, in determining the infiltration capacity of flooded soils for:

Surface irrigation and drainage projects.

Infiltration or water purification basins.

Seepage from watercourses, canals, basins or wastewater lagoons.

Soil leaching at waste storage sites.

Research into the effects of cultivation.

Research into drainage effects.

Research into badly permeable layers of sports fields.

Troubleshooting

If horizontal insertion of the infiltration ring and the driving plate is not successful, a stone or a root might impede the process. Choose another spot for measuring.

If the infiltration rate proves not to be constant, continue measuring. A variance of less than 10% per interval is considered as constant.

Increased infiltration is established. This may result from:

Macro pores. They tend to occur in soils susceptible to shrinkage (cracks and fissures resulting from drought), as a result of vegetation (rooting), soil fauna, or in strongly disturbed topsoil (ploughing). Insert the ring well into the soil, to below the disturbed top layer. Carry out measuring at several representative spots to obtain a reliable mean infiltration curve of the soil or landscape unit.

Disturbance of the soil caused by installation of the ring. Bentonite or other types of clay may be used to heal crusted or disturbed soils. Play between the infiltration ring and the ground can be fixed by applying soil.

If the water level in the inner ring exceeds the level in the outer ring, buffering against lateral spreading is insufficient. Make sure the water in both rings has the same level.

In well-layered soils, water will tend to strain off sideways, despite the use of the double ring. If necessary, determine the infiltration curve of the underlying layers separately in a pit.

Too high a water level in the infiltration rings will cause the water to spread laterally. The maximum water level should be 5 -10 cm.

Sustained measuring will increase lateral spreading.

Infiltration is below expectation. Several factors may be the cause:

The soil is crusted. First, establish the infiltration curve of the undisturbed (crusted) soil, then remove the crust and measure again. A large difference in infiltration indicates the occurrence of a crust. Usually the crust will measure less than 1 centimetre (Bouwer, 1986).

If the water level in the outer ring exceeds the level in the inner ring, water from the inner ring will hardly infiltrate and may become negative. Make sure the water has the same level in both rings.

The water poured into the rings has disturbed the soil structure. Protect the soil and use plastic foil, a jute cloth, sponge, or a 1-2 cm layer of sand or gravel. It is also possible to pour the water on the ground via your hand.

Water used for measuring, containing sediments or other suspending agents may cause a low-permeable layer. Use water of a similar quality and temperature to that of the soil of which you are measuring the infiltration capacity.

References

Bouwer, H., 1986. Intake rate: cylinder infiltrometer. In: methods of soil analysis, part I. Physiscal and mineralogical methods. Agronomy Monograph no. 9 (2nd ed.). Am. Soc. of Agronomy, Soil Sc. Soc. of America.

DIN 19682-7, 1997. Bodenuntersuchungsverfahren im Landwirtschaftlichen Wasserbau - Felduntersuchungen - Teil 7: Bestimmung der Infiltrationsrate mit dem Doppelzylinder-Infiltrometer.

Green, W.H. & G.A. Ampt, 1911. Studies in soil physics, part I. The flow of air and water through soils. J. Agric. Sci. 4. ILRI, 1974. Drainage principles and applications, vol. III: Surveys and investigations.

Ward, R.C. & M. Robinson, 1990. Principles of Hydrology. McGraw-Hill Book Company, London.

Item 21

Date :
Location :
Remarks :

FIELD LIST

Eijkelkamp
Agrisearch Equipment
a Royal Eijkelkamp Company

A	B		C	D	E	F	G	H
Time	Water level		Cumulative time	Time interval	Infiltration	Infiltration capacity	Infiltration capacity	Cumulative infiltration
	before filling	after filling						
Reading hour min sec	*Reading* mm	*Reading* mm	*Determine from A* min	*Determine from A* min	*Determine from B* mm	*Calculate from D & E* mm/min	*Calculate from F* .. / ..	*Determine from E* mm
			start = 0					start = 0

Item 22

Grass Shears & Paper Sample Bags

See Item 20 for Instructions

Item 23

Scale

No Instructions

Getting to Know Your Pastures: Techniques to Enhance Monitoring

University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources

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Abstract

A photo-monitoring system and other monitoring techniques can help land managers achieve their pasture management objectives. Photo-monitoring can capture a vast amount of data, and other monitoring procedures can be added to measure quantitative goals.

Why Monitor?

Monitoring is key to rangeland and pasture management. You may have heard the phrase "you can't manage what you don't measure." What do you want your pastures to look like? All managers should monitor to evaluate changes and progress toward management goals. Others may document pasture health for carbon credits, government programs, or absentee landowners. If you are receiving credit for improving pasture health, you may want to document your pasture and management. Records also can paint a long-term picture of production for realtors or lenders.

Grazing records should be included as part of the overall monitoring program. This includes grazing dates and stocking rates for each pasture. The UNL Extension Circular Grazing and Hay Records: Spreadsheet Template (EC165) is available as a tool for keeping grazing records. Plant growth is linked to precipitation, so it is important to record your precipitation amounts from October to September (the vegetation-year).

Where to Monitor

Choose a typical and representative area of a pasture to monitor. A uniform pasture may only need one photo point; complex pastures need more. For example, a hilly pasture with valleys would need two photo points — one on the hills and one in the valleys.

Areas to avoid:

- ungrazed or lightly used areas — steep hills, pasture corners, locations over 1 mile from water
- overused areas - less than ¼ mile from water, fence, or fence corners
- areas that funnel cattle movement - tight draws, cow trails.

What is Photo-Monitoring?

Photo-monitoring is the simplest way to monitor short or long-term changes in pasture and rangeland. This orderly collection, analysis, and interpretation of resource data can evaluate progress toward meeting management objectives quickly and easily. Photographs alone provide a wealth of information but must be accompanied with, for example, plant and weather data to realize the full potential. Photo graphs of the same site over time allow you to see differences at a glance. A photograph is truly "worth a thousand words." Photo-monitoring is repeatable and makes it easy to compare year-to-year changes in vegetation cover, growth, and density. Photographs can show:

- the condition of the pasture;
- the type and abundance of species;
- ground cover and residual (standing herbage);
- erosion (wind or water);
- effects of fire, late freeze, drought, hail, grasshoppers; and
- healing of problem areas (washouts, control of cedar trees).

At a minimum, photographs should include a Photo Point and Photo Plot. For more intense monitoring, a Photo Point can be accompanied with several Photo Plots of that area. A picture is qualitative, so other methods are needed for quantitative data.

When to Monitor

Take photographs at least once a year after the growing season when the plants have matured. More frequent monitoring can show seasonal changes.

What Type of Monitoring Should Be Done?

The amount and intensity of monitoring is flexible and should be developed to match your individual ranch or pasture goals. The type of monitoring program you should use is the one that gives you the information you need in making management decisions. Data can be recorded and organized through photographs and hand written notes, electronically on a computer, or by using the UNL Rangeland and Pasture Photo-Monitoring App called "GrassSnap."

The following are examples of goals and monitoring procedures. Develop goals and choose monitoring techniques that match your production system.

Item 24

Figure 1. Photographs should include a pasture landscape scene (left) taken as a Photo Point and Photo Plot (right) to capture details of the grass and soil surface.

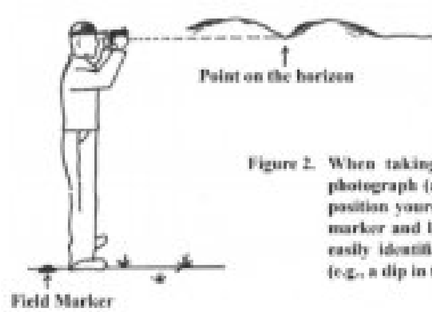

Figure 2. When taking a landscape photograph (a Photo Point), position yourself at the field marker and line up with an easily identifiable landmark (e.g., a dip in the hills).

Document Changes in Plant Density or Height, Abundance of Weedy Plants, Washouts, or Blowouts

<u>How to Collect:</u>

Photo Point: General landscape of key area(s). Landscape photographs include a large area looking out toward the horizon

Find a representative area and place a field marker. Look out on the horizon and choose a point (could be a large hill or a dip in a valley) that can easily be located year after year. Use the same location every year (see Figures 1 and 2).

<u>Equipment Needed:</u>

Camera, GPS and/or field marker, compass, clipboard/ paper/markers, perspective pole.

Field markers are used to mark the point in the pasture where the photographer stands. Try to avoid tall markers that could attract curious cattle or markers that could ruin tires. Short PVC pipe or steel fence posts driven into the ground, and flat metal disks are examples.

Perspective pole is used for easy reference of grass height and density. A 5-foot tube or shovel handle with alternating black and white stripes about 1 foot apart works well. Start with black on top, as the top of the pole will provide better contrast against the sky.

When taking the Photo Point image, place the perspective pole the same distance from the field marker. The purpose of the perspective pole is just that — to keep perspective in photographs taken over multiple years.

Records of Ground Cover, Plant Density, Plant Residue, or Plant Composition

<u>How to Collect:</u>

Photo Plot: A nearer photograph that gives more detail about a key area. The photograph is taken looking straight down at the grass and soil (Figures 1 and 3).

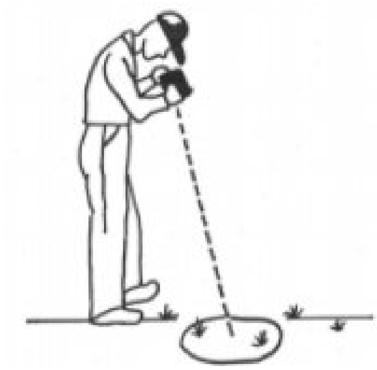

Figure 3. When taking a Photo Plot, look straight down at the ground. Try to keep your shadow and feet out of the picture. Optional: place your hoop or frame in the picture for size reference.

Photo Plots can be taken from the field marker used for the Photo Point image. Walk out a few steps and place a hoop or square on the ground. Look straight down and take a picture.

Equipment Needed:

Camera, hoop or square (optional), GPS and/or field marker, compass, clipboard/ paper/markers for reference in the picture. A hoop, or plot frame, can be made of any flexible material, usually tubing or rope. If the frame is 58.9 inches in circumference, the frame also can be used to measure pasture production as in the next example.

Forage Production

How to Collect:

Clipping: A small area of forage is clipped, dried, and weighed to estimate total forage production (lb/ac).

- Place.a frame of known size in a representative area. For our calculations, use a round plot frame (58.9-inch circumference).
- Ensure the frame is sitting directly on the soil surface.
- Clip to ground level only the forage plants rooted within the frame.
- Remove plants your animals won't eat (noxious or unpalatable weeds).
- Measure the weight of an empty paper bag in grams.
- Place clipped forage in a bag.
- Dry forage for more accurate results.

  Tip: The forage will dry in a few days if left on the dashboard of a vehicle.
- Weigh the bag of forage in grams. Subtract the weight of the empty bag.
- If the forage is not dried, multiply by dry matter content percent to figure total dry matter per acre. Calculate dry weight (use NRCS charts to determine % DM).
- Multiply the dry weight minus the weight of the bag times 50 for total forage in pounds per acre.

Estimate of total forage = (Dry weight of forage in bag in grams – weight of bag in grams) × 50

- Divide by 4 for a rough estimate of grazable forage in pounds per acre.

Estimate of grazable forage (Dry weight of forage in bag in grams – weight of bag in grams) x 50 = 4

Note:

An approximate stocking rate can be calculated from production data. Contact an Extension or NRCS office for information.

Clipping multiple samples from different locations will provide a better estimate of average pasture production.

When determining annual forage production on most types of pasture, clipping an ungrazed area in August or later is recommended to best represent that season's growth.

Drying charts only give an estimate of percent moisture, so drying the clippings is the most accurate way to measure dry matter.

Equipment Needed:

Hoop or square, clippers, scale that measures grams, paper bags, oven or dashboard for drying (Figure 4).

Species Composition or Ecological Status and Health of Plant Communities

How to Collect:

Plant Identification — Identify key forage species that should be or are desirable to have in your pastures. Look up characteristics to identify plants, or take pictures or samples to be identified. Some plants may require help from your local extension office to identify. Place samples in a resealable plastic bag and refrigerate for best preservation.

Equipment Needed:

Plant identification book or website; NRCS ecological site descriptions for plant communities.

Estimate of Potential Production and Plant Species. Provide a visual observation of the level of utilization (grazed vs. ungrazed) within a pasture.

How to Collect:

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Figure 4. Find a representative area and place your plot frame (left). Clip plants rooted in the plot frame. Follow the instructions to estimate forage production.

Figure 5. A simple exclosure built to monitor the recovery of a burned pasture.

“Fishbowl”or exclosure: Fence off a small exclosure. Small flexible panels and steel poles would be sufficient (Figure 5). Plant composition and production can be estimated in the exclosure where animals are unable to graze. Keep exclosures at the same location for a maximum of two years before moving.

Equipment Needed:

Fence or small panels, posts (Figure 5).

Set up Next Year’s Grazing Rotations

How to Collect:

Grazing indexes: find a grazing index for your type of pasture/plant community.

It may take time to understand how to use indexes. An example is the Sandhills Defoliation and Response System (SanDRIS) for the Sandhills region (see Resources).

Fill out the required information. Use it to develop next year’s planned rotations for optimal pasture health.

Every index is different, so read carefully before using.

Equipment Needed:

Grazing records and dates grazed, precipitation records, residual/litter. Number of head and estimated weights of animals also should be included. Data sheet for recording.

Calculate Stocking Rate of Animals for a Pasture

How to Collect:

Grazing and production records — Demand can be calculated with the following data: number of head, size and kind of animal, and length of time in a pasture.See “clipping” for estimating production in a pasture.

Equipment Needed:

.

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Data sheet or electronic version for grazing, calculator. Electronic grazing records to help balance stocking rates are available in Excel® in the UNL Extension Circular Grazing and Hay Records (EC165).

Summary

A good photo-monitoring system will help land managers stay on track with their goals. Pictures capture a vast amount of data as Photo Points and Photo Plots. Other methods can be added to measure quantative goals, such as clipping for production and plant identification. Personalize your monitoring so the data you collect will be useful in your range management. Remember to monitor what you want to manage and develop a custom system to fit.

Hints, Tips, and Basics of Photo-Monitoring

▪ Set up permanent markers, so the same spot and Photo Point are photographed each year. Use GPS to identify these locations.

▪ Monitor the same pasture at the same time each year, unless you are gathering seasonal information. (A holiday or other significant date can help you remember.)

▪ Monitor at the end of the growing season when all the plants have matured (in the fall). A cool season wheatgrass pasture would mature in late June to early July, while warm season rangeland monitoring could wait until mid-September.

▪ The "fishbowl" exclosure can indicate potential plant production or how much forage is grazed during the non-monitored time frame.

▪ Use tools that will help with visual scale, such as a perspective pole or plot frame.

▪ Take extra batteries for your camera or GPS. Check your camera storage card to ensure it has enough room for the photo-monitoring pictures.

▪ Take Photo Point pictures horizontally with ¼ of the picture as sky and ¾ as vegetation.

▪ Use the same focal length on your camera every year (don't zoom in or out).

▪ For Photo Plots, fill the camera window with the entire plot frame. The closer you are, the easier it will be to see details in the picture.

▪ Avoid shading the frame with your shadow in Photo Plot pictures. Shadows make it difficult to identify the plants.

▪ Print off pictures of Photo Points (and GPS locations) and take these with you every year, so you can line up the Photo Point in the same place in future years. (If you use the UNL Rangeland and Pasture Photo-Monitoring App, activate the "Overlay" feature.) Note which direction you are looking.

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