Plan Grazing Management Using the Oklahoma Grazing Stick

October 2016

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The amount of forage produced in pastures changes each year mostly due to rainfall and temperature fluctuations. Hot and dry years tend to have less forage production than wet and temperate years. Most of the time, the changes in forage production are not considered in the grazing management and the herd size is kept constant rather than adjusted to match the amount of produced forage. Consequently, pastures tend to be overgrazed in hot and dry years and undergrazed during wet and temperate years. Contrary to expectations, overstocked pastures decrease animal gain and forage production. Grazing forages close to the ground (i.e., less than 3 inches stubble height) decreases the amount of sugars and other nutrients left for pasture regrowth, thus reducing forage production in subsequent years. This situation is aggravated by the absence of fertilization in introduced pastures intended to replenish animal forage extraction. Even though the worst consequences to pastures occur during overstocking, understocking also has its own negative effects. The excess forage will mature, resulting in low forage quality, livestock consumption and animal gains. The mature forage will substantially reduce, even cease, leaf and stem growth to invest its energy in seed production. Moreover, undergrazed pasture may need to be burned early in the next season, which is an extra cost for removing the top deteriorated forage layer and allowing sunlight into the canopy for initiating new shoot growth.

For that reason, matching the correct herd size and grazing time with pasture production every year is crucial for maintaining long-term pasture productivity and profitable animal production. Forage production can be measured, estimated or simply guessed from experience. Forages can be accurately measured by clipping and weighing, which is a labor intensive and time-consuming method. On the other hand, the grazing stick allows a quick estimate of forage production based on readings of forage height and canopy cover. At the first glance, the grazing stick seems like a simple yard stick, but it is a complete measuring system. Grazing sticks vary from state to state to accommodate the most pertinent guidelines according to the region. However, most grazing sticks have the same features, such as a ruler for measuring forage height and canopy cover, conversion tables, formulas and grazing guidelines for quick pasture management decisions. Although different grazing stick models look alike, it is recommended the producer uses the grazing stick developed for his/her own state, because the forage estimates presented in the tables may change across the region. Those estimates are developed based on forage clippings performed for each region and, consequently, their values will differ to better ac-

commodate each forage production potential for each region. The grazing stick model that best fits your location can be found by accessing the link: http://articles.extension.org/pages/28873/finding-a-pasture-stick-in-your-area-for-your-organic-dairy-farm.

The objective of this Fact Sheet is to support producers estimating forage production in a rotational grazing system by mastering the use of the Oklahoma grazing stick to properly modify herd size and number of grazing days. Even though the Oklahoma grazing stick is the focus of this publication, most of the procedures described here are applicable for all grazing sticks.

Using the Grazing Stick

The Oklahoma grazing stick contains the following features, printed on the stick itself:
- General guidelines and tables for pasture management and planning
- A ruler to measure forage height and canopy cover
- Equations to calculate number of animals, available grazing, etc.

All tables described in this Fact Sheet are present on the Oklahoma grazing stick, with the exception for Table 5, which makes it a complete forage production and animal allocation system. The procedures of how to use the Oklahoma grazing stick can be divided into three major steps: 1) defining your management system, 2) estimating forage availability and 3) forage allocation.

Defining Your Management System

Producers can choose from keeping the cattle all season long in one big pasture (i.e., continuous grazing) to moving the cattle daily among small pastures (i.e., mob grazing). The grazing efficiency of an operation increases as the number of pastures increases. This happens because the herd will be confined in a smaller area for a shorter period of time, resulting in less forage waste due to less trampling, defecation and forage selection. However, the costs related to fencing, water and labor will also increase as the number of pastures increases. Furthermore, different types of livestock demand different grazing periods for optimum gain and different pas-

tures need different resting periods for maximum regrowth. To achieve an affordable cost and successful operation, the management system should be tuned by trading off changes among:

- The optimum pasture grazing period based on livestock type (Table 1).
- The recommended pasture rest period based on forage growth rate and pasture type (Table 2).
- Grazing system efficiency based on animal forage utilization (Table 3).

For instance, choosing the lowest cost and efficient system (continuous) results in the longest grazing period and no resting period, which would be inappropriate for raising dairy cattle in a slow growth native field because it may lead to pasture overgrazing. Moreover, choosing the highest cost and efficient system (daily rotation) results in the shortest grazing period and the longest forage resting period would be inappropriate for raising goats in a rapid growth introduced pasture because it may lead to pasture undergrazing. Conversely, choosing an intermediate cost and efficient system (eight paddocks) containing a reasonable grazing and rest period would be appropriate for raising stockers in an introduced rapid to moderate growth forage.

Table 1. Optimum grazing periods.

Animal Kind	Optimum grazing periods
Cow/calf, sheep, goats	3 – 7 days
Stockers/growing animals	1 – 3 days
Dairy	½ - 1 day

Table 2. Recommended Rested periods.

Growth rates	Introduced	Natives
Rapid growth	15 – 25 days	25 – 45 days
Moderate growth	25 – 35 days	45 – 60 days
Slow growth	35 – 50 days	60 – 90 days

Table 3. Grazing efficiency based on pasture utilization.

Season Long	Native Pastures	Tame or Introduced Pastures
Continuous Grazing	25%	30%
4-6 pastures	25%	40%
8-10 pastures	30%	50%
12 pastures	35%	60%
Strip grazing, <20 paddocks or daily rotation	not recommended	75%

The information provided in Tables 1 and 2 can be used as inputs for the Equation 1. This equation calculates the number of pastures units. After this, the grazing efficiency of your grazing system can be estimated by entering the number of pastures in Table 3. Those two pieces of information, number of paddocks and grazing efficiency, will be used in future calculations.

$$\text{Number of Pastures} = \frac{\text{Rest Days}}{\text{Graze Days}} + 1 \qquad [\text{Equation 1}]$$

Case study: A producer has 500 acres of bermudagrass, and is planning to raise beef cattle in this area. In this case, the maximum graze period for beef cows is three days (Table 1), and the bermudagrass, which is a rapid growth/introduced forage, needs to have at least a resting period of 15 days (Table 2).

$$\text{Number of Pastures} = \frac{15}{3} + 1 = 6$$

Therefore, the number of pastures needed for a functional operation is six pastures of approximate 83 acres (500 ÷ 6), which confers a grazing efficiency of 40 percent (Table 3).

Even though Tables 1, 2 and 3 allow us to calculate the number of pastures and grazing system efficiency, keep in mind that this is a rough estimation based on simple Oklahoma state average values. Those average values may not be adequate for a specific operation considering that pastures have a natural yield variation. Therefore, it is necessary to estimate the forage availability for each pasture unit to refine the operation system planning.

Estimating Forage Availability in Pastures

Find Random Spots for Measurements

Measurements should be taken prior to moving livestock to each pasture unit. Walk through the pasture and find random spots. In other words, do not choose the area to the measured. Never select the highest- or lowest-yielding spots because it leads to under- or overestimation. The main objective is to take enough samples that cover the whole pasture variability. As a rule of thumb, it is recommended to take 15 to 20 pairs of measurements (plant height and canopy cover) per pasture. However, the number of measurements depends on how uniform the pasture is. Productive and uniform bermudagrass pastures would demand no more than 15 measurements. On the other hand, a bermudagrass pasture that contains both good and bad areas would need at least 20 measurements for accounting all its variability. Keep in mind that distribution of forage types should be also accounted. For instance, a pasture dominated by bermudagrass on one side and by fescue on the other side must be split into two sections, and the measurements of each section should be worked through the grazing stick methodology separately, then averaged.

Case study: After determining the number of pastures and grazing efficiency, the producer visually realized that the six bermudagrass pasture units have a natural production variation among them. The eastern pastures have higher and even stands than western pastures. Therefore, at least 20 measurements in the western pastures and no more than 15 measurements in the eastern pastures will be needed. One of the pasture units is dominated by bermudagrass on one side and by fescue on the other. For this specific pasture, the producer split it into two sections, and the measurements of each section were worked through the grazing stick methodology separately, then averaged.

Record Plant Height

a. Place the grazing stick vertical to the ground,
b. Look at the ruler face of the stick, record the average height of the plants in that specific spot.

To find the proper plant height, gently push your hand into the canopy and record the height where you start to feel a modest resistance from the forage leaves against your hand (Figure 1A). Feeling a modest resistance from the forage leaves means that your hand already touches half of the plant leaves under your hand. Do not pull the leaves up. Do not record the highest leaf or shoot (Figure 1B). Focus in measuring the height where leaves are found if the forage already has an elongated seed head. Trampled spots should be avoided; however, if most of the pasture was trampled or lodged, lift the plants up to their natural stand and measure the proper height rather than stretching them.

Record Canopy Cover

a. At the same spot of the plant height measurement, slide the stick under the canopy with the ruler facing up.
b. Count the inch marks covered by vegetation out of 33,
c. Multiply the total number of covered inch-marks by three to estimate the percent canopy cover.
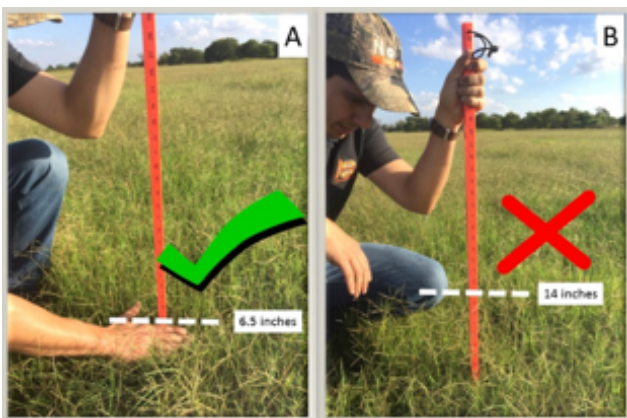

Figure 1: Proper (A): average forage leaves height. Improper (B): highest plant or shoot. Focus in measuring the height where leaves are found if the forage already has an elongated seed head.
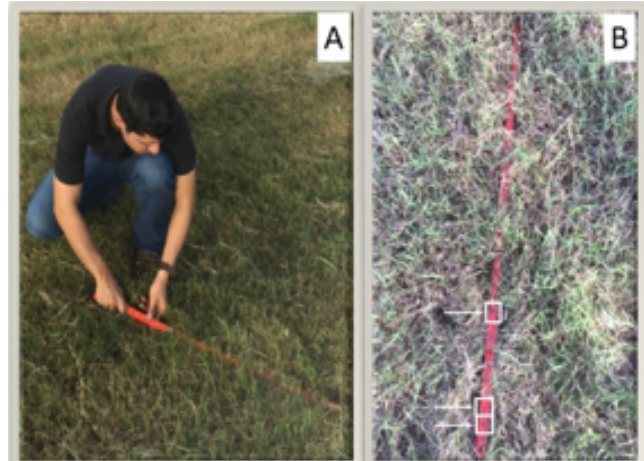

Figure 2: Estimating canopy cover: (A) slide the stick under the canopy with the ruler facing up, and (B) count the inch-marks covered by vegetation out of 33. Three uncovered marks; therefore 27 covered out of 33.

Case study: the first canopy cover reading in one of bermudagrass pasture units is 27 inch-marks of 33 are covered by the forage canopy, then:

27 x 3 = 81 percent canopy cover

Estimate Dry Forage per Acre-inch ($DF_{acre-inch}$):

a. Average the canopy cover readings collected in step 3,
b. Using Table 4, select the dry matter range based on most appropriate forage type and average canopy cover.

Case study: the producer measuring the first bermudagrass pasture estimates an average canopy cover of 85 percent after 18 random measurements, and this pasture is assigned to the 75 to 90 percent cover which estimates 375 pounds of $DF_{acre-inch}$. However, he could estimate 250 pounds of $DF_{acre-inch}$ if the averaged canopy cover was in the lower range, e.g. 75 percent; or he could estimate 300 pounds of $DF_{acre-inch}$ if the average cover was in the middle range, e.g. 80 percent?

Table 4: Estimated Available Standing Dry Forage (lbs acre^{-1} inch^{-1}).

Forage types	50-75% Cover	75-90% Cover	>90% Cover
Bermudagrass	125 - 225	250 - 375	450 - 600
Fescue	75 - 150	175 - 250	300 - 425
Introduce Mixed grass/Legume	125 - 200	225 - 325	350 - 475
Introduced bluestem	100 - 175	200 - 300	325 - 450
Native – Mixed Prairie	75 - 125	150 - 225	275 - 400
Native Tallgrass Prairie	125 - 175	175 - 250	275 - 325

Estimate the Available Dry Forage for Livestock per Acre (DF_{acre}):

a. Average the plant height readings collected in step 2,
b. Subtract the average height from the residue height (Table 5) in order to find the forage height available for grazing,
c. Multiply forage height available for grazing by the $DM_{acre\text{-}inch}$ (step 4) for estimating the $DM_{total\text{-}acre}$.

It is very important to consider the residue height in this calculation. The proper residue height is to ensure that some stems and leaves remain in the pasture for quick regrowth. Grazing below the residue height slows regrowth and decreases yield. On the other hand, the forage quality and animal gain will progressively decrease as height increases after overcoming the "begin graze" height recommended in Table 2. In other words, the forage might hold a decent quality at higher height than the ones recommended for beginning grazing; however, the forage quality will be not at its optimum level anymore.

> **Case study:** the producer estimated that the average height of the first bermudagrass pasture is 4 inches and that the $DF_{acre\text{-}inch}$ is 375 pounds after 18 measurements. In this case, the available dry forage for grazing is:
> 4 inches (average height) – 2 inches (residue height) = 2 inches
> Then, the DF_{acre} is:
> 2 inches (available for grazing) x 375 pounds per acre-inch^{-1} = 750 pounds per acre^{-1}.

Allocating forage to Livestock

Forage allocation to livestock can be done by calculating either the available number of animals or grazing days. Regardless the approach, the entries necessary for this calculation are:

- Available dry forage for livestock per (DF_{acre}, lbs acre^{-1})
- Pasture unit size (acres)
- Grazing efficiency (%), Table 5
- Daily Forage needs per animal unit (lbs head^{-1}), Table 6

Table 6. Forage needs per animal unit (1,000 lbs).

Animal Kind	lbs day^{-1}
Cattle	27
Cow w/ calf <3	30
Cow w/ calf >3	39
Calves < 12 months	18
Yearlings 12-18 months	24
Dairy Cows	42
Bulls	39
Horse	38
Sheep/goats	6

Keep in mind that the forage needs in Table 6 are based on an animal weighing 1,000 pounds. The forage needs will need to be re-adjusted if the animals weight is higher or lower than 1,000 pounds.

If the producer is starting an operation and still planning on purchasing livestock, it is wise to calculate the number of animals (Equation 2) that the property can support based on the animal forage needs and the fixed number of available grazing days for each pasture calculated by Equation 1. This is exactly the approach in the Case Study presented in this Fact Sheet. On the other hand, the producer might be interested in calculating the available grazing days in each pasture unit based on the fixed number of animals that compose his/her herd (Equation 3). This second approach fits well in an ongoing operation with the capability of expanding the total pasture acreage, reducing the herd size and/or introducing best managements practices for improving pasture production such as proper rotation, fertilization and weed control.

$$\text{Number of Animals} = \frac{DF_{acre}\left(\frac{pounds}{acre}\right) \times \text{Acres} \times \left(\frac{\text{Grazing efficiency (\%)}}{100}\right)}{\text{Daily forage needs (\%)} \times \text{Number of grazing days)}}$$

[Equation 2]

$$\text{Grazing days} = \frac{DF_{acre}\left(\frac{pounds}{acre}\right) \times \text{Acres} \times \left(\frac{\text{Grazing efficiency (\%)}}{100}\right)}{\text{Daily forage needs (\%)} \times \text{Number of grazing animals)}}$$

[Equation 3]

Table 5: Grazing management guidelines.

Forage types	Begin graze	Residue height	Rest Days
Bermudagrass	4 inches	2 – 3 inches	18 - 28
Fescue	6 inches	3 – 4 inches	21 – 30
Introduce Mixed grass/Legume	4 – 6 inches	2 – 4 inches	20 – 30
Introduced bluestem	4 inches	2 inches	25 – 35
Native – Mixed Prairie	8 – 12 inches	4 – 8 inches	30 – 90
Native Tallgrass Prairie	8 – 12 inches	4 – 8 inches	30 – 90

Case of study: Once the producer wants to introduce beef cattle in his bermudagrass pastures, the forage need per animal unit (1,000 pounds) is 27 pounds day^{-1} (Table 6). However, the average weight of the animals that he is introducing to the operation weight 1,200 pounds. In this case, the forage needs per animal is:

$$\frac{27 \times 1,200}{1,000} = 32.4 \text{ lbs/day}$$

Furthermore, the number of animal units that the first bermudagrass pasture can support is:

$$\text{Number of Animals} = \frac{750 \times 83 \times \left(\frac{40}{100}\right)}{32.4 \times 3} = 256 \text{ beef cows}$$

The final step is to adapt the grazing system based on the calculations above. As mentioned before, the number of pastures units, grazing days and rest periods are calculated using rough values. However, the grazing management can be fine-tuned based on the estimation of forage availability and forage allocation for each pasture unit. Adapting the grazing system is a task that requires versatility and technical knowledge. Furthermore, keep in mind that the grazing stick forage estimates are simply based on the state average; therefore, it is wise to interpret the results as a reference rather than as an accurate value. It is wise to be conservative when planning, in other words, expect lower production from your pastures. In this case, the chances of overgrazing, the worst case scenario, is minimized. The worst that can happen is a minor undergraze condition if a conservative approach is adopted. Minor undergrazing can be easily fixed by increasing the herd next season. Nonetheless, it would be ideal to have the most realistic grazing stick estimates for each specific pasture because it would result in more accurate calculations for developing a proper grazing system. For that reason, the grazing stick can be calibrated for specific pastures for higher accuracy.

Case Study: The producer calculated the number of animals that each bermudagrass pasture would support based on the estimated forage values:

Pasture ID#	Acreage	Available forage	Number of animals	Graze days	Rest period
1 – west pasture	83	750 lbs/acre	256	3	15
2 – barn pasture	83	750 lbs/acre	256	3	15
3 – lake pasture	83	400 lbs/acre	154	3	15
4 – west road pasture	83	350 lbs/acre	102	3	15
5 – east road pasture	83	350 lbs/acre	102	3	15
6 – east pasture	83	350 lbs/acre	102	3	15

The producer confirmed his visual inference during measurement collection. There was a gradient in pasture production from west to east. Therefore, it is not appropriate to stock 256 beef cows in each of the six pastures for the same grazing period because pastures 3, 4, 5 and 6 will be overgrazed. The opposite is true, stocking only 102 animals is not appropriate either because pastures 3, 4, 5 and 6 will be undergrazed. In this situation it would be appropriate to fuse pastures 3 and 4 with 5 and 6 by summing their acreage, averaging their available forage:

Pasture ID#	Acreage	Available forage	Number of animals	Graze days	Rest period
1 – west pasture	83	750 lbs/acre	?	?	15
2 – barn pasture	83	750 lbs/acre	?	?	15
3 – lake + W road	166	375 lbs/acre	?	?	15
4 – E road + bottom	166	350 lbs/acre	?	?	15

Using a modified version of Equation 1, the number of grazing days would be recalculated respecting that the bermudagrass demands at least 15 days for proper regrowth (Table 2).

$$\text{Grazing days} = \frac{\text{Rest Period}}{\text{Number of pastures} - 1} = \frac{15}{4 - 1} = 5 \text{ days}$$

Case Study (cont'd)

According to Table 1, five days of grazing is an acceptable period for beef cows. Therefore, the number of animals can be recalculated for all pastures using Equation 2. Note that the grazing efficiency of the operation still can be considered 40 percent, because it is in the 4 to 6 pasture range (Table 3):

Pasture ID#	Acreage	Available forage	Number of animals	Graze days	Rest period
1 – west pasture	83	750 lbs/acre	153	5	15
2 – barn pasture	83	750 lbs/acre	153	5	15
3 – lake + W road	166	375 lbs/acre	153	5	15
4 – E road + bottom	166	350 lbs/acre	143	5	15

After combining the pastures, the he/she is able to support 153 beef cows in pastures 1, 2, 3 and 143 beef cows in pasture 4. As mentioned above, it is wise to be conservative and expect lower production from pastures to avoid overgrazing; therefore, the producer would opt for introducing a herd of 143 cows averaging 1,200 pounds. He/she would increase the herd next year if they observe that grasses are recovering faster than proposed (15 days). Also, he/she would invest in soil analysis and proper fertilization for improving pasture production especially in pastures 3 and 4, allowing more cows in next years. For proper fertilization refer to the Oklahoman Pasture Fertility Guide available at: http://npk.okstate.edu/documentation/factsheets/Pasutre%20Handbook/E-1021web.pdf

The Oklahoma Cooperative Extension Service
WE ARE OKLAHOMA

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.

- It is administered by the land-grant university as designated by the state legislature through an Extension director.

- Extension programs are nonpolitical, objective, and research-based information.

- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.

- It utilizes research from university, government, and other sources to help people make their own decisions.

- More than a million volunteers help multiply the impact of the Extension professional staff.

- It dispenses no funds to the public.

- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.

- Local programs are developed and carried out in full recognition of national problems and goals.

- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.

- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.