A Method of Determining Stocking Rate Based on Monthly Standing Herbage Biomass

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Stocking rate is the number of animals (animal unit) for which a grassland unit (acre) can provide adequate dry matter forage for a specified length of time (month). Stocking rate depends on the amount of herbage biomass available to grazing animals, the time of year, the type of grazing system used, and the amount of forage consumed by livestock per month. Stocking rate is commonly presented as acres per animal unit month (AUM) or its reciprocal, AUM's per acre.

Forage dry matter intake of grazing animals is affected by the size of the cow. Large cows consume more forage than do medium- and standard-sized cows. A more accurate estimate of daily or monthly forage demand of livestock on grazinglands can be determined with the metabolic weight of the animal than with its live weight. Metabolic weight is live weight to the 0.75 power. A 1000-pound cow with a calf is the standard, which is defined as 1.00 animal unit (AU) and has a daily dry matter allocation of 26 pounds of pasture forage. The metabolic weight of a 1200-pound cow with a calf is 1.147 animal unit equivalent (AUE), which has a daily dry matter allocation of 30 pounds of pasture forage. The metabolic weight of a 1400-pound cow with a calf is 1.287 animal unit equivalent (AUE), which has a daily dry matter allocation of 33 pounds of pasture forage. The amount of forage dry matter consumed in one month by one animal unit, a 1000-pound cow with a calf, is an animal unit month (AUM). The daily dry matter allocation for a cow with a calf on pasture is different from the daily dry matter requirement for just the cow during the same production periods. During the grazing season from May through November, the length of the average month is 30.5 days.

The mathematical process used to determine stocking rate from herbage biomass is presented in table 1. The amount of herbage available during the grazing season is the average value of the mean monthly standing herbage biomass values for the grazing-season months. The mean monthly standing herbage biomass should be determined by clipping and weighing the dry herbage from each pasture and averaging the weights over several years. If these values are not available, the generalized values for western North Dakota native rangeland (table 2) can be substituted. The general monthly herbage values on the herbage weight curve in table 2 are averages of herbage production on well-managed pastures during years with normal precipitation.

Each of the monthly herbage biomass values needs to be adjusted to reflect the differing effects various grazing treatments have on the quantity of herbage biomass produced. Time of year and intensity of defoliation vary with different grazing treatments; these variations affect plant biological mechanisms and result in the production of different amounts of herbage. The percentages of the potential amount of herbage biomass produced on various grazing treatments are summarized in table 2. The monthly herbage biomass values for the months of the grazing season can be adjusted for differences in herbage biomass on specific grazing treatments by multiplying monthly herbage weight by the percentage of potential herbage produced on a particular grazing treatment.

The effects of drought conditions can suppress herbage biomass production for 1 to 4 years, depending on the health status of plants prior to water deficiency periods. This reduction in herbage production must be reflected in the calculations to determine accurate stocking rates during the drought and recovery periods. These adjustments need not be determined for growing seasons in which herbage biomass is not affected by current or previous drought conditions.

Each of the monthly herbage biomass values during drought and during the perennial plant recovery period needs to be adjusted to reflect the percentage of herbage weight reduction that resulted from the effects of drought conditions. The percent reduction that results from the effects of drought conditions can be determined by a comparison of normal-year herbage biomass and drought-year or recovery-year herbage biomass. If these data are not available, estimations based on several years of experience can be used. The estimate of percent herbage reduction needs to be converted to percent of

herbage biomass produced. The percent of herbage produced is determined by subtracting the percent reduction in herbage from 100%. The monthly normal-year herbage biomass values adjusted for the effects of grazing system are multiplied by percent of herbage produced to adjust for the effects of drought conditions.

The average monthly herbage biomass is determined by adding the adjusted monthly herbage biomass for the months of the grazing season and dividing the sum by the number of grazing-season months.

Not all of the average herbage biomass for the planned months of the grazing season is consumable forage. Perennial plants must retain a portion of the leaf material to conduct photosynthesis and provide carbohydrates and other products necessary to sustain healthy and productive growth. The amount of leaf material the plant must retain ranges from 40% to 60%, depending on grassland type (40% on the shortgrass, 50% on the midgrass, and 60% on the tallgrass prairies). When specific values for percent proper utilization are not known for the grassland type, an average value of 50% may be used. This value implies that the plant retains half the herbage and half the herbage is available for utilization.

Not all standing herbage available for proper utilization is ingested by grazing animals. Grazing livestock consume only about 50% of herbage available for utilization. The remainder of the utilized herbage is broken from the plant, soiled by animal waste, consumed by insects and wildlife, and lost to other natural processes. Data to allow comparison of forage-harvest efficiency on different grazing systems are not available. However, the quantity of herbage ingested by livestock would be expected to increase with improvement in efficiency of harvest from some grazing systems.

The differences in daily dry matter intake for cows of different weights are used to adjust stocking rates for cow size. The standard 1000-lb cow requires 26 lbs of dry matter per day. The dry matter intake for lighter or heavier cows can be determined by multiplying 26 lbs by the animal unit equivalent (table 3), which is based on the metabolic weight of the cow.

For determination of stocking rate, the available monthly forage for intake value adjusted for grazing system and drought conditions is divided by the amount of dry matter per cow per month--the daily amount of dry matter per cow adjusted for cow size and multiplied by the number of days per average month (30.5 days). This stocking rate is presented as AUM's per acre. The reciprocal can be determined by dividing that number into 1 to give acres per AUM. This is the number of acres required to provide forage for one month for a cow with a calf.

Stocking rates vary with the amount of herbage production and are determined from the average monthly herbage biomass for the months of the grazing season and the weight of the cows. The quantity of the standing herbage in grassland pastures is not constant during the period grazed. The weight of the herbage dry matter per acre increases during the early growth stages until the maximum plant height is reached, and then the dry matter weight decreases as the mature plants dry during senescence. Table 4 shows the stocking rates for different average monthly herbage biomass quantities and cow sizes.

The number of cows to turn onto the grazing system is determined by dividing the total number of acres in the pastures of a grazing system by the acres per AUM value and dividing this total number of AUM's by the number of months of the grazing season. The number of cows that can graze the pastures subtracted from the total number of cows in the herd will show any forage shortfall.

The stocking rate value determined by this mathematical process is based on the average monthly standing herbage biomass for the grazing-season months and has been adjusted for percentage utilization, percentage forage intake, grazing system, cow size, and the effects of drought conditions.

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Table 1. Process to determine stocking rate from monthly herbage biomass.

Adjustment for grazing treatment

Monthly herbage biomass value (from clipped and dried samples or from table 2) X % of potential herbage produced on appropriate grazing treatment (from table 2)

Adjustment for effects of drought conditions

Monthly herbage biomass value adjusted for grazing treatment X (100 % - % herbage reduction)

Average monthly herbage biomass

Sum of adjusted monthly herbage biomass for the months of the grazing season

÷ number of grazing season months

Adjustment for size of cow

26 lbs daily dry matter intake X Animal Unit Equivalent for appropriate cow size (from table 3).

Stocking Rate

Average monthly herbage biomass adjusted for grazing treatment and for drought conditions

X % proper utilization (50%)

X % consumed (50%)

= lbs of available monthly forage

÷ dry matter per AUM (26 lbs X AUE X 30.5 days)

= AUM/ac

reciprocal
1.0 ÷ AUM/ac = ac/AUM

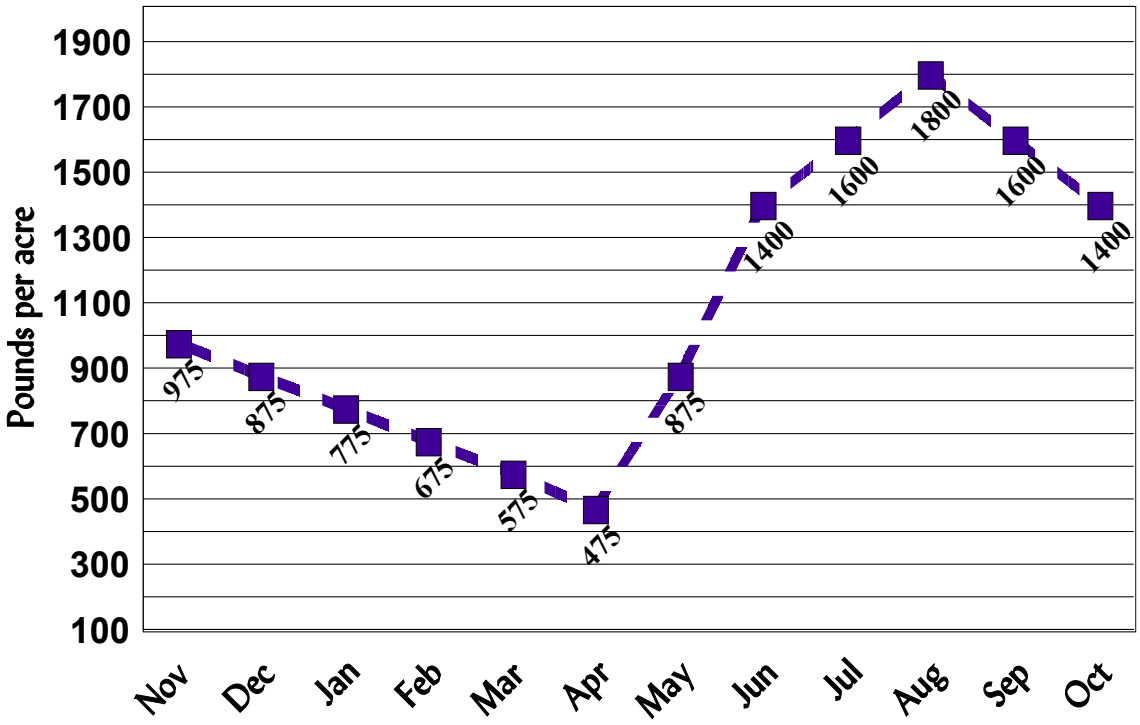
The number of cows that can graze the available forage

Total number of acres in grazing system

÷ acres/AUM

÷ number of grazing season months

Table 2. Generalized Standing Herbage Biomass for Well-Managed Native Rangeland during Normal Precipitation Years



Seasonlong	start 1 May	30% of Potential Herbage
6.0 Seasonlong	start 15 May	50% of Potential Herbage
4.5 Seasonlong	start 15 Jun	70% of Potential Herbage
4.0 Deferred	start 15 Jul	90% of Potential Herbage
4.5 Short Duration	start 15 Jun	95% of Potential Herbage
4.5 Twice Over	start 1 Jun	100% of Potential Herbage

Table 3. Animal Unit Equivalent (AUE) based on metabolic weight (live animal weight $^{0.75}$).

Animal Live Weight (lbs)	Animal Unit Equivalent $y^{x\ 0.75}$ (% of 1000 lbs)
600	0.682
650	0.724
700	0.765
750	0.806
800	0.846
850	0.885
900	0.924
950	0.962
1000	**1.000**
1100	1.074
1200	1.147
1300	1.217
1400	1.287
1500	1.355
1600	1.423
1700	1.489
1800	1.554
1900	1.618
2000	1.682
2200	1.806
2400	1.928
2600	2.048
2800	2.165
3000	2.280

Table 4. Stocking rates (acre/AUM) for different quantities of average monthly herbage dry matter biomass (DM lb/acre) and three weights of cows.

Stocking Rates acre/AUM	1000 lb Cows Herbage Biomass DM lb/acre	1200 lb Cows Herbage Biomass DM lb/acre	1400 lb Cows Herbage Biomass DM lb/acre
1.00	3172	3660	4084
1.25	2538	2928	3267
1.50	2115	2440	2723
1.75	1813	2091	2334
2.00	1586	1830	2042
2.25	1410	1627	1815
2.50	1269	1464	1634
2.75	1153	1331	1485
3.00	1057	1220	1361
3.25	976	1126	1257
3.50	906	1046	1167
3.75	846	976	1089
4.00	793	915	1021
4.25	746	861	961
4.50	705	813	908
4.75	668	771	860
5.00	634	732	817

Procedure to Determine 12-Month Nutrient Requirements for Cows with Different Calf Birth Dates

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Beef cows require energy, protein, minerals, vitamins, and water. The daily quantities of each nutrient required by the cow depend on the size of cow, level of milk production, and production period (dry gestation, 3rd trimester, early lactation, lactation). The quantities of nutrients required by cows for 12 months depend on the month in which calf birth occurs. Calf birth date affects the time of year during which the production periods occur and the length of the production periods. The length of the production periods and the time of the year during which they occur determine the type of forage available during any given production period and the amount of forage needed from pasture or from harvested forage.

The 12-month quantities of dry matter, energy (TDN), crude protein, calcium, and phosphorus required by cows having average milk production but different weights and different calf birth months can be determined with the procedures presented in this report, the worksheet provided, and the information provided about the daily nutrient requirements (table 1) and the length in days of the production periods and forage types for calf birth dates for 4 months (table 2). A separate worksheet for each cow-size category and month of calf birth will need to be completed. A worksheet for 1200-pound cows with calf birth dates in March is provided as an example to illustrate the procedures.

In the appropriate spaces near the top of the worksheet, record the cow weight and calf birth month. On the appropriate line in the top section of the worksheet, place the number of days for the production periods and forage types corresponding to the selected calf birth month. These figures can be found in table 2, which was developed to have low numbers of acres per cow per year and to implement management strategies that graze domesticated grass and native rangeland pastures at the proper time of year. Domesticated grasses reach grazing readiness about a month earlier than native rangeland and can be grazed starting in early May. Native rangeland is ready to be grazed starting in early June. With the use of rotation grazing systems based on grass phenology, the nutritional quality of native rangeland can be manipulated to match requirements of lactating cows until mid October. Domesticated grass pastures of wildrye types can provide adequate nutrients for lactating cows until mid November. Harvested-forage rations will provide adequate nutrient levels during the remainder of the year.

Check the values for the days at the right side of the worksheet to ensure that the total number of days on ration and days on pasture equals 365. Locate the daily nutrient requirements in pounds for the various production periods from the appropriate cow-weight category on table 1, and record these requirements in pounds on the middle section of the worksheet.

To determine the number of pounds of nutrients required for each production period and forage type, multiply the pounds of nutrients required per day by the number of days in the period and for the available forage type. Record these values in the appropriate spaces on the bottom section of the worksheet. Combine the nutrient quantity values for ration-forage and pasture-forage types. Then add the total values for ration forage to the total values for pasture forage to determine the total quantity of required nutrients for a 12-month period for the selected cow weight and calf birth month. Record these values in the bottom right section of the worksheet.

The quantity of nutrients required by a cow for 12 months is variable and depends on cow weight and calf birth month. The quantity of nutrients provided from harvested forage in rations and from pasture forages varies with calf birth month because different forage types are available during production periods that occur at different times of the year.

Worksheets for the methods described in this report should be copied before procedures are begun.

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