Guidelines for Visual Assessment of Herbage Mass in Pastures

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Estimates of total and useable amounts of forage dry matter (DM) in a pasture are essential for budgeting feed to livestock and for forecasting pasture supply. Herbage mass or pasture mass is the amount of above-ground forage DM per unit land area, expressed on an oven-dry basis (usually 60 C/140 F, 100 C/212 F, or microwave oven-dried to constant weight). Oven-drying removes weight variation due to differences in herbage DM concentration, which ranges from 15-50% of fresh weight. Herbage mass is a basic pasture condition measurement and usually does not represent the amount of forage that may be consumed by grazing animals. Prudent levels of livestock utilization based on plant and animal performance requirements typically range from 50-80% of herbage mass.

Reference methods for determining herbage mass involve clipping to nearly soil-surface level, oven-drying, and weighing numerous samples from measured areas. Herbage mass is usually expressed in units of lb DM/ac in the USA, while scientific publications and most other countries use units of kg DM/ha. These units are roughly interchangeable as follows:

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\text{kg/ha} \times 0.89 = \text{lb/ac} \quad \text{and} \quad \text{lb/ac} \times 1.12 = \text{kg/ha} \quad \text{(e.g., 1000 kg/ha = 890 lb/ac).}
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Electronic and spring balances adequate for herbage mass estimation cost as little as $40-$200. Factors to convert grams (g) of oven-dry forage from clipped quadrats (typically 0.1 m² or 1 ft² in area) to field estimates are: kg DM/ha = g DM/0.1 m² x 100 or g DM/ft² x 108, and lb DM/ac = g DM/0.1 m² x 89 or g DM/ft² x 97. Clipping is often considered too tedious and time-consuming by pasture managers, but is useful for calibration of rapid techniques including rising plate meters and measuring sticks (Fig. 1).

Fig. 1. Use of measuring stick for calibration and estimation of herbage mass. The same sampling area is shown in Figs. 2 and D.

Fig. 2. Sampling area shown in Figs. 1 and D clipped to nearly ground level (reference method).
A practical and rapid method of herbage mass assessment is visual comparison with known standards such as photographic images. The development of visual and hand tactile (sense of feel) assessment of differing pasture conditions, in conjunction with sample clipping (Fig. 2), drying, and weighing, can help a pasture manager to become calibrated to rapid estimation of herbage mass. With experience, this can be done reliably to within 500-800 kg/ha (450-700 lb/ac) of actual levels as determined by reference methods. Visual and tactile assessment of herbage mass is a function of differing height, density, growth stage, DM concentration, and canopy structure. These relationships are not necessarily addressed by measuring stick methods (Fig. 1) and will vary among species and between irrigated and dryland conditions.

Herbage mass is typically estimated to within 1 cm (approximately 0.4 in) of the soil surface. Based on production objectives, pasture managers must establish target levels of residual stubble height, leaf area, or herbage mass that will remain after grazing. Although livestock are capable of grazing a pasture canopy to nearly ground level, pasture recovery and production usually suffer from close grazing. As pasture height decreases, livestock encounter physical constraints to harvesting forage and intake rates decline. The intake requirements of high-producing livestock cannot be met with canopy heights below approximately 8-10 cm (3-4 in). These heights correspond to herbage masses of approximately 1200-1500 kg/ha (1100-1300 lb/ac) for many irrigated cool-season pasture species and mixtures. Effective regrowth of pasture grasses depends on retention of at least 6-8 cm (2.5-3 in) of stubble. This is where reserves for regrowth are stored in stem bases and where residual live leaves for capturing sunlight energy are located. Residual herbage mass targets may vary from as little as 800-1000 kg/ha (700-900 lb/ac) to as much as 1800-2000 kg/ha (1600-1800 lb/ac). These targets depend on plant species and physiological requirements for regrowth, expected levels of animal performance, timing and frequency of grazing, and management objectives.

Images A-F with orchardgrass, meadow brome, tall fescue, birdsfoot trefoil, and white clover represent a spectrum of conditions and canopy heights that would be found in well-managed cool-season pastures under irrigation. These provide reference points for developing the ability to visually assess herbage mass. Herbage masses increase in increments of roughly 500-1400 kg DM/ha (450-1200 lb DM/ac) among images. Supplemental use of the hand to sense canopy density and strength, DM concentration, and leaf proportion and arrangement will improve herbage mass estimation. Square quadrats in these images are 0.32 m (12.5 in) along each inside dimension and 0.1 m² (1.08 ft²) in area, and are held at approximately a 45-degree angle in contact with the ground.

Image A is generally representative of minimum residual (following grazing) herbage mass for plant recovery and performance, while B is generally representative of minimum initial (prior to grazing) herbage mass for high animal performance. Images C and F display the greater bulk density of ryegrass and clover, relative to more open and grass-dominant canopies with lower tiller density such as orchardgrass (D) and tall fescue (E). Meadow brome in A and B has intermediate tiller density relative to the other species. Other pasture species and mixtures with different relationships between herbage mass and canopy characteristics can be learned and assessed accordingly. In comparing the images with known levels of harvested grass and legume hay production, recall that forage harvesting machinery leaves substantial residual stubble, while these figures reflect forage sampled to nearly soil surface.

Once familiar with visual assessment of herbage mass, pasture managers can improve their abilities to budget forage to livestock and determine amounts of forage to reserve for mechanical harvest if necessary. They can also use this technique to estimate harvest efficiency and pasture growth rates, forecast future forage supply, and plan adjustments in stocking rate to balance forage supply with livestock demand. Supplemental images with known herbage masses can be assembled to represent pasture conditions beyond those featured here.
A) 1150 kg DM/ha 1030 lb DM/ac
Meadow brome/birdsfoot trefoil (8 cm, 3 in)

B) 2250 kg DM/ha 2010 lb DM/ac
Meadow brome/white clover (13 cm, 5 in)

C) 3610 kg DM/ha 3230 lb DM/ac
Perennial ryegrass/white clover (19 cm, 7.5 in)

D) 4150 kg DM/ha 3700 lb DM/ac
Orchardgrass/birdsfoot trefoil (27 cm, 10.5 in)

E) 4990 kg DM/ha 4450 lb DM/ac
Tall fescue/white clover (15 cm, 6 in)

F) 5740 kg DM/ha 5120 lb DM/ac
Perennial ryegrass/white clover (23 cm, 9 in)