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Terminology Revisited: Effective Communications for the Agricultural Community

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Abstract: In 1862 (when USDA established) about 60% of the U.S. population were farmers, but in 2000 it was around 2%. Many people from a diversity of backgrounds are returning to small acreages and are newcomers to agriculture. Pasture-based production systems for meat goats, sheep, and cattle are growing rapidly in the eastern U.S., especially on smaller-scale farms. Increasing demand for U.S.-grown agricultural products, including pasture-raised meat and dairy products, requires renewed efforts to relay practical production agriculture information as effectively as possible. We emphasize the need to return to use of standardized terminology when explaining soil, plant, and livestock management practices.

Introduction

The sheep (*Ovis aries*) and goat (*Caprus hircus*) industries (especially hair sheep and meat goats) are growing rapidly on many small-scale livestock farms in the Appalachian Region of the eastern U.S. The growth is occurring in part to help satisfy the demand created by ethnic markets and changing demographics of the North American population. There also is increasing interest in pasture-finished production systems because of consumer health benefits, practices that might mitigate environmental concerns, and production economics with lower fuel and purchased feed costs. Increasing demand for pasture-raised meat and dairy products for niche markets requires renewed efforts to communicate the best management and production information as effectively as possible. Successful small-scale enterprises are based on an understanding of fundamental relationships in the soil-plant-grazer continuum and terminology used to describe system components and management practices.

A consistent terminology is important when trying to convey to producers best management practices for forage and livestock resources. Many people from a diversity of backgrounds are returning to small acreages and are newcomers to agriculture in the U.S.; learning and understanding the terminology to communicate with researchers (Hanson, 1995), Extension agents, advisory personnel, and experienced grasslanders are essential, especially with the emphasis on distance education (Twidwell & Venuto, 2004).

A concerted effort in the early 1990s by a variety of professional organizations (Glossary Revision Special Committee, 1989; The Forage and Grazing Terminology Committee [TFGTC], 1991; CSSA, 1992) to foster this sort of communication by defining and encouraging the use of common terminology in agricultural research and Extension efforts. These definitions were sanctioned and endorsed by many groups (ADSA, AFGC, ASA, ASAS, CSSA, SRM, and SSSA), but as is the case with all things in time, use of standardized terminology seems to be decreasing.

Purpose and Objective

We emphasize the need for a renewed use of a consistent and unified terminology, and consider some common soil-forage-livestock terms. Our goal is to help improve dialogue on grazing management on pasturelands among smaller-scale livestock farmers, and the agricultural Extension, advisory, and research communities. The terminology presented here is for practical agricultural situations and, in some cases, may depart from purely technical applications.

Soil

Soil is defined as the unconsolidated mineral or organic material on the immediate surface of the earth. Soil is a product of geological and environmental effects arising from interactions of microorganisms, climate, and animals that can serve as a natural medium to support plant growth (CSSA, 1992; Ortmann, Roath & Bartlett, 2000).

A soil amendment is any material such as lime, gypsum, sawdust, compost, animal manures, crop residues, or synthetic soil conditioners that can be incorporated into the soil or applied on the surface to enhance plant growth (SSSA, 2008). Amendments often contain important nutrient elements found in fertilizers, but physical amendments commonly refer to materials other than those used as fertilizers. Fertilizers include organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more nutrients essential to the survival and growth of plants (SSSA, 2008).

Manure is composed of feces (dung) and urine from production livestock, including poultry and wildlife. Feces and urine are released from animals separately (except poultry), but when livestock are allowed to lounge or congregate in shaded areas or watering sources in a pasture or are confined to a barn or lot, the feces and urine become mixed together.

The feces is high in organic matter from undigested plant fiber and unabsorbed nutrients and macro- and microminerals, whereas urine is composed mainly of water, urea (nitrogen), potassium, sodium, and trace amounts of other minerals. Urea, once excreted, converts rapidly to ammonia.

In confinement situations, bedding materials high in organic matter such as hay, straw, sawdust, wood chips, peanut hulls, rice hulls, shredded newspaper, or many other high fiber plant by-products are used to absorb water to help keep pens dry and to slow ammonia release. When removed from the pen, this manure (feces plus urine) and associated bedding material can be applied onto pasture or cropland. In some cases, manure is composted prior to field application.

Forages

There are an estimated 250 to 500 thousand plant species on earth, but only a small fraction of these have economic value (Botanical Society of America, 2008). Approximately 19 thousand plant species occur in the U.S. (Bramwell, 2002), with about 50 of these species used for forage production (Moore, 2003).

Forage is a general term that includes herbage, forbs, and browse (TFGTC, 1991). Herbage is defined formally as grasses and grass-like plants (does not include the grain), while forbs are broadleaf plants. Forbs by definition include legumes and herbs. Pasture managers consider forage legumes as a separate specialized group within the general group of forbs. Forbs may be better defined as plants other than grasses or forage legumes. There is emerging interest in evaluating herbs and other non-traditional plant resources (and even re-evaluating traditional plant resources) for plant constituents that benefit feed intake, rumen fermentation, digestion, and nutrient-use efficiency, as well as control gastrointestinal parasites in livestock. Browse is defined as leaf and twig growth of shrubs, woody vines, trees, cacti, and other non-herbaceous plants. Mast refers to the fruit and seed of browse (TFGTC, 1991) and is used to describe diets of free-ranging wildlife (NC Department of Environmental and Natural Resources, 2008).

Evaluation of Forage Mass

Measurement of Herbage Mass, Forb Mass, or Browse Mass

Forage mass refers to the dry weight of aboveground forage produced on a defined unit of land (TFGTC, 1991). The term mass can be coupled with herbage, forb, or browse to estimate the amount of aboveground material. The quantity of dry matter (mass per unit area; DM) is expressed as DM per hectare. Available forage for livestock is the "potentially available forage" and represents the forage mass. Not all forage present in a sward is available to the grazer because of different modes of prehension and selection preference by the grazer; structure of the plants (stolon mass of white clover, for example); the presence of thorns or secondary plant metabolites that deter consumption; or fouled and trampled plants when animals graze a pasture.

Forage mass is used to estimate the number of grazing days based on the known or estimated daily DM intake by grazing livestock. Intake depends on forage quality, and often times forage quality dictates intake.

Forage Quality vs. Forage Nutritive Value

Forage quality depends on a number of factors, including animal performance (i.e., milk production, growth, wool production), forage intake, and nutritive value of the forage. Each of the three factors interacts and is influenced by a variety of other factors. Forage quality and forage nutritive value are often times misused interchangeably. The proximate analysis procedures uses subsamples of a composite forage sample to determine six nutritive value fractions (Table 1).

Table 1.
Proximate Analysis Scheme

Fraction	Method	Removes	Mathematical Relationships
Water	Drying oven 100° C	Water	$100 - \% \text{water} = \% \text{Dry Matter (DM)}$
Ash or Mineral Matter	Muffle furnace 600° C	Organic Matter	Residue = %Ash $100 - \% \text{Ash} = \% \text{Organic}$

			Matter (OM)
Crude Fiber (CF)	Subject sample to ether extraction, then dilute sulfuric acid digestion	Proteins, sugars, starches, soluble hemicellulose, and minerals	Residue = %Crude Fiber
Crude Protein (CP)	Kjeldahl Procedure (sulfuric acid digestion)	Nitrogen-containing compounds (protein, enzymes, vitamins, urea) as total nitrogen	Total %N * 6.25 = %CP
Crude Fat (CFat)	Ether Extraction	Fat, vitamins, carotene, chlorophyll, sterols, phospholipids, waxes, oils	Residue = %Fat Residue used for crude fiber analysis
Nitrogen-free Extract (NFE)	Mathematical Difference	Starches, sugars, soluble hemicellulose	NFE = 100 - % water - %CP - %CFat - % CF - % ash

Five of the fractions are traditionally determined using wet chemistry procedures, while the nitrogen-free extract fraction is determined mathematically using the other five fractions. The fiber fraction of forages is defined best for ruminants with neutral detergent fiber (NDF) and acid detergent fiber (ADF) using Van Soest procedures (Goering & Van Soest, 1970; Van Soest, Robertson, & Lewis, 1991) (Table 2). The proximate analysis parameters and Van Soest parameters (either determined by wet chemistry procedures or by near infrared reflectance spectroscopy) as reported can be used as comparative indices for different forage plants; this comparison based on chemical parameters is termed nutritive value as it is the "potential nutritive value" for livestock.

Table 2.
Sequential Van Soest Forage-Feed Fiber Analysis Scheme

Fraction	Fraction Components
Neutral Detergent Fiber (NDF)	Plant cell wall components
	(Cellulose, Hemicellulose, Lignin)
Acid Detergent Fiber (ADF)	Plant cell wall components
	(Cellulose, Lignin)
NDF minus ADF =	Hemicellulose
Acid Detergent Lignin (ADL)	Lignin
ADF minus ADL =	Cellulose

In vitro dry matter disappearance (IVDMD) is associated with the digestibility of the forage. This technique uses rumen fluid collected from a ruminant, mixed with a buffer solution, and incubated with a dried, ground forage sample; resulting data are used to estimate the DM digestibility (estimated DMD; also termed digestible dry matter [DDM]) of the forage. This in vitro digestibility is an estimate of nutrient disappearance from the rumen (stage 1) or pre-intestine disappearance (stage 2). It is not an estimate of the total tract digestibility. Specialized feeding trials, termed metabolism trials, must be conducted to account for nutrient losses via the feces and urine so that in vivo or total tract digestibility of a nutrient can be estimated. When forage nutrient-use by animals is coupled with forage chemical analyses (NDF, ADF, IVDMD, CP), the term forage quality is appropriate.

Livestock and Grazing

Animal Unit

A standard animal unit is defined by TFGTC (1991) as one, mature, non-lactating bovine weighing 500 kg and fed at a maintenance level, or the equivalent, expressed as $(\text{body wt., kg})^{0.75}$, in other classes of animals.

For most practical uses, it would take five ($[500 \text{ kg}^{0.75}]/[60 \text{ kg}^{0.75}]$) sheep (adult, female, non-lactating, weighing 60 kg), or six ($[500 \text{ kg}^{0.75}]/[52 \text{ kg}^{0.75}]$) goats (adult, female, non-lactating, weighing 52 kg) to equal one standard cow unit grazing pasture. If younger lambs or kids at lighter weights are used, then the numbers to replace one cow unit would need to be calculated based on the weight and metabolic body size.

Livestock Classes

Cattle, sheep, and goats graze differently by selecting different plants and plant parts to satisfy nutrient demands. Cattle use the tongue to convey forage to the mouth, while sheep and goats use the lips (Van Soest, 1996). Cattle are considered grazing animals, whereas goats are classified as browsing animals; sheep are somewhat intermediate.

When allowed to choose freely, grazing cattle typically select diets that contain 70% herbages (represented by grasses and legumes), 20% forbs, and 10% browse, whereas goats select about 30% herbages, 10% forbs, and 60% browse, with sheep diets represented by 50% herbages, 30% forbs, and 20% browse (Van Dyne, Brockingham, Szocs, Duck, & Ribic, 1980). Goats are often used to control noxious weeds and browse as an alternative to chemical herbicides (Williams & Prather, 2006). Because of diet preferences that differ by livestock groups, producers can take advantage of this selectivity through grazing management practices to help improve the nutritive value and overall forage utilization of pastures.

Grazing Management

Grazing management is the planned use of a group of ruminants to harvest forage and can be either extensive or intensive. Extensive grazing management allocates a relatively large land area to grazing livestock with less emphasis on controlling sward use, maintaining a stocking density matched to the growth patterns of the dominant plants, or the behavior of the grazers that requires less labor, resource, and capital inputs (TFGTC, 1991).

Stocking rate is often misused to mean stocking density. Stocking rate involves defining the number of animals per unit of land for a specified period of time. It is basically the stocking density for a specified period of time, usually days. The number of days a sward is grazed is often not reported in published manuscripts or is implied based on the length of the average growing season when referring to stocking

density. The number of days in a growing season increases from north to south in the eastern U.S., and is usually determined by the frost-free interval of the year. In the southeastern U.S., dry and hot conditions in summer and early autumn very often dictate the duration of the growing season.

Modern producers have implemented intensive grazing management to improve forage utilization by using more labor along with resource improvements and capital investments. Modernization of fencing (including traditional woven wire or barbed wire, high-tensile electrical fencing, and portable electrical fencing), water resources (ponds, wells, spring developments), and water distribution systems are resource improvements, and in most cases involve capital investments.

Intensive management generally is a grazing plan that synchronizes duration of the grazing interval with the growth characteristics of the plant stand, by moving or adjusting the number of grazers on a given land area. The advent of portable and relatively easy-to-install electrical fencing makes this possible and more practical.

Intensive grazing management, when considered from the whole farm perspective, may be more appropriately referred to as management-intensive grazing (MiG) as defined by Gerrish (2004). The integration of soil fertility, forages, livestock, resource improvements, marketing, capital investment, and farm goals are all part of management that must be intensified for successful, sustainable grazing for livestock production.

We limit our discussion here and refer to the use of intensive grazing management as a method to maintain plant productivity and high nutritive value for improved forage utilization by grazing livestock. Within both of these generalized areas of extensive and intensive grazing management, producers can couple different methods of stocking for successful forage management and animal production.

Continuous Stocking and Rotational Stocking

Continuous stocking and rotational stocking are referred to as continuous grazing and rotational grazing, respectively. Continuous stocking and rotational stocking relate the stocking density (number of animals per unit of land area) to grazing management method when ruminants are used to harvest forage. In continuous stocking, a defined number of livestock are allotted to a specific size unit of land and allowed unrestricted grazing on the designated area for a period of time (sometimes for the entire grazing season or plant growing season). This method of stocking pastures may not give plants time to rest between defoliation events to allow for sufficient re-growth. In addition, if a pasture is fertilized with nitrogen, and then managed with continuous stocking, less than one-third of the forage mass is harvested by grazing livestock with the remainder being trampled, used as bedding or a resting spot, and dung-fouled by livestock (Anderson, 2008).

With rotational stocking, the specified unit of land is usually divided into two or more units termed paddocks, then a specified number of livestock are allotted to the first paddock and allowed to graze for a period time before being moved to the second paddock, and so on. Paddocks are rested to allow forages time to re-grow. Animals are moved between or among paddocks throughout the grazing (plant growing) season. Rotational stocking helps to maintain desirable forage with high nutritive value for grazing livestock. Botanical composition of the stand determines the growth pattern, and very often the plant growth rate. This influences the duration of the rest interval needed to achieve targeted herbage mass.

Management recommendations for most improved forages are based on utilization efficiencies of 50 (continuous stocking) to 80% (rotational stocking, hay production) of the available sward. A decreased forage-utilization efficiency by grazing livestock can be a result of difficulty in maintaining a desirable botanical composition in mixed swards (Belesky, Fedders, Ruckle, & Turner, 2002), plant growth rates, defoliation frequency, and overall forage nutritive value (Burns, Chamblee, & Giesbrecht, 2002). The use of

four paddocks would allow for a 75% rest time for plants. Usually a 30 to 40-day rest period is sufficient for most herbage and legumes to re-grow and replenish foliage and roots sloughed as a result of defoliation by grazing livestock.

Rotational stocking improves distribution of nutrients from urine and dung in paddocks. With the increasing costs of fertilizers, dividing a pasture into paddocks may improve the distribution of recycled nutrients from manure, maintain forage persistence, and allow for more efficient forage utilization by grazers. With continuous stocking, nutrients from manure often are concentrated around water sources (West, Mallarino, Wedin, & Marx, 1989) and lounging areas, especially areas used for shade (Mathews, Sollenberger, Nair, & Staples, 1994).

Specialized Grazing Methods for Different Age Groups of Animals

The set number of animals allotted to a paddock sometimes involves the entire gang of goats, flock of sheep, or herd of cattle. Specific grazing methods accommodate doe-kid, ewe-lamb, or cow-calf pairs; weaned animals; non-lactating females; and breeding sires. The methods ensure that younger animals, having the greater nutritional need compared to older animals, have priority access to forage with high nutritive value.

First-Last Grazer

Grazing livestock often are grouped when specific nutritional requirements exist (i.e., weaned animals or non-milking adult females). The weaned animals graze the defined land area first and are subsequently moved to another area, then non-milking adult females graze the area from which the weaned animals first grazed. Animals are managed with rotational stocking.

Forward Creep Grazing

This method is basically a first-last grazing scheme, but applied to doe-kid, ewe-lamb or cow-calf pairs where the nursing offspring are allowed access to the next paddock in the sequence via a creep gate (Blaser & Colleagues, 1986) through which the dams cannot pass. Dams are subsequently moved to the creep paddock, and the creep gate is moved so that offspring have access to a new paddock for grazing prior to the dam. Animals are managed with rotational stocking.

Mixed Grazing

The mixed grazing option uses more than one animal species to manage pastures (TFGTC, 1991). Mixed grazing is often referred to as multi-species grazing or co-species grazing. The use of the term "multi-species" is confusing and often times leaves the reader wondering if this relates to many plant species (mixed sward) or many animal species (mixed grazing) in a pasture.

Mixed grazing is typically some combination of beef cattle and sheep, or beef cattle and goats, or horses and goats, or horses and sheep, or horses and cattle. By using mixed grazing, overall forage-use is often improved, and elimination of undesirable weeds and brush is accomplished without the use of chemicals. Luginbuhl, Green, Poore, and Conrad (2000) reported that grazing goats and beef steers together controlled multiflora rose (*Rosa multiflora* L.) and other undesirable weed species. Adding goats did not affect forage mass available to beef steers because the dietary preferences differed. Others have reported advantages in weight gains when cattle and sheep grazed together (Abaye, Allen, & Fontenot, 1994). Mixed grazing with beef cattle and sheep or beef cattle and goats has been used to control of gastrointestinal (GI) parasites, mainly by reducing fecal egg counts (Marley, Fraser, Davies, Rees, Vale, & Forbes, 2006) for improved

animal performance.

Considerations

Since 1862 (when USDA was established), the percentage of people engaged in farming has declined from 59% of the U.S. population to less than 1.9% in 2000. Since 2000, people from a diversity of backgrounds are returning to small-scale farming operations. These small-scale farms are scattered across the landscape and might be isolated from other similar operations. A common language or terminology will help bridge the gap. The following should be considered:

- Communicating practical technology with common-use terminology will facilitate delivery of practical agricultural knowledge and wisdom for new small-scale farmers.
- Authors, reviewers, editors, and educators must again strive for and incorporate standardized terminology used in agricultural publications and presentations.
- Standard terminology publications for soils, plants, and livestock in pasture and range environments should be updated as emerging technologies and refined managements popularize new terms such as targeted grazing and tall grazing.
- Field days, workshops, in-service trainings, symposia, and distance education venues can make standardized terminology accessible to a wide audience for improved communication and understanding.

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