Soil Quality Information Sheet

Pastureland Soil Quality—
Indicators for Assessment and Monitoring

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What are indicators?

Indicators are key soil or plant community characteristics that are measurable and are sensitive to change in management practices or the environment. Trends in condition can be interpreted from regularly measured indicators that provide clues about the response of the system to management. Environmental factors, such as time since the last rainfall, can affect some indicators and should be considered when the effects of management are interpreted.

What indicators are used on pastureland?

Soil properties.—Physical, biological, and chemical soil properties are included. Some physical properties, such as bulk density and soil strength, reflect limitations to root growth, seedling emergence, and water infiltration. Chemical properties, including plant nutrients, organic matter, cation-exchange capacity, base saturation, and pH, directly affect plant production and the ability of the plants to provide soil cover. Soil organisms, such as earthworms, are also soil properties. Some of these are beneficial organisms, but some are harmful, including insect larvae and nematodes that can reduce or destroy forage stands or infect livestock. Organic matter in the soil and the aggregate stability of the soil reflect a combination of physical, biological, and chemical processes.

Soil surface features. —Pedestals, exposed plant roots, rills, gullies, wind scours, terracettes, penetration resistance, stoniness, and soil or plant residue movement and deposition (debris dams or windrows after major storms) reflect such processes as runoff and erosion. These indicators are commonly assessed qualitatively.

Vegetative features.—Such features as plant cover, desirable species, plant residue, plant vigor, and species diversity are indicators that reflect the makeup and vegetation cycling of the current plant community.

Management factors.—Visibly evident features, such as uniformity of plant removal, excessive use areas, adaptation of the pastureland species, plant stress resulting from insects or disease, and currently modified soil fertility and pH, help to determine the effects of management on the site. Often, these are the primary causes for changes in soil quality.

Environmental conditions.—The level of physiological stress exhibited by the plants results partly from the weather and other environmental conditions of the site at the time of the assessment.

Spatial patterns and variability.— Landscape position, erosion, and deposition affect the distribution and cycling of water and nutrients in pastured soils. Nutrient distribution is affected by the kinds, amounts, and spatial distribution of living plants and decaying residue on the soil. As the distribution of soil organic matter and animal waste becomes less uniform because of poor grazing or traffic distribution, resource availability decreases in some patches and increases in others.

Table 1.—Pasture condition indicators.
From "Guide to Pasture Condition Scoring" and the "National Range & Pasture Handbook," available at www.glti.nrcs.usda.gov. Additional soil quality indicators are described in Soil Quality Information Sheets, available at http://soils.usda.gov/sqi.

Indicators	Areas of concern			
	Soil, site stability	Site hydrology	Plant community productivity	Livestock (or wildlife) performance
Percent desirable plants	I	I	D	D
Plant cover	D	D	D	I
Plant diversity	I	I	D	I-D
Plant residue	D	D	D	D
Plant vigor	I	I	D	D
Percent legume	I	I	D	I-D
Uniformity of use	I	I	D	D
Livestock concentration areas	D	D	D	I-D
Soil compaction	D	D	I-D	I
Erosion	D	D	I-D	I
Soil fertility	I	I	D	I-D
Soil pH (reaction)	I	I	D	I
Severity of use	D	D	D	D
Site adaptation of desired forage species	D	D	D	D
Climatic stresses	I	I	D	D
Disease and insect pressure	I	I	D	I-D
Salinity and/or sodicity	I	I-D	D	I-D

D–direct impact; I–indirect impact; I-D–direct and indirect impact.

Assessment

A pasture assessment estimates or measures the functional status or condition of pastureland. The assessment must start with a consideration of the land user's desired plant community, production goals, and environmental goals. The appropriate Natural Resources Conservation Service (NRCS) forage suitability group report can help the land user to formulate a pasture plant community and production goal that will be the standard at the site. Information from this report should be supplemented, whenever possible, with updated information from local university extension forage references.

The timing of assessments depends on seasonal cycles. Some soil properties are highly variable on a daily, seasonal, or yearly basis in response to changes in both temperature and moisture. For example, the total amount of organic matter in a soil is relatively insensitive to seasonal changes. In contrast, soil compaction, which is detected by penetration-resistance tools, varies with soil moisture and temperature, which depend on recent weather conditions. In this case, there should always be a reference site, such as one along a fence line, that is free of livestock traffic to use as a comparison with in-pasture compaction measurements.

The optimum time and location for making assessments depend on the objectives. Potential objectives include:

- selection of sites for monitoring (e.g., riparian zones, heavily used areas, and areas with noxious weeds),
- gathering of inventory data used in making decisions (e.g., soil test samples and reports),
- identification of areas at risk of degradation (e.g., streambanks, shorelines, and access lanes), and
- targeting of management inputs (e.g., stocking procedures, fertilizer, water developments, and overseeding).

Careful site selection helps to ensure that the assessment sites are truly representative of the pasture. A pasture that lies on a varied landscape is best evaluated by sampling each representative landscape position and soil or by sampling only those landscape positions where obvious problems are noted. The sampling sites should be on the same soil and in the same landscape position as the area of interest. Offsite features, such as crop fields, woodlots, hedgerows, farmsteads, roads, and other areas of recent or past disturbances, can have significant impacts and should be noted. The management history of the site can aid in interpretation. For instance, the pasture stand is sparse in a recently converted row-crop area.

Monitoring

Monitoring identifies changes in the resource through the orderly collection, analysis, and interpretation of quantitative data. It must be conducted over time at permanently marked locations and include baseline data if it is to ascertain the trend of the change in the functional status of the pasture. Monitoring is often designed so that different observers can make measurements consistently. Baseline data or standards may be used to establish management goals and aid in interpretation of the monitoring results.

Site selection for monitoring depends primarily on the objectives, which include:

- evaluation and documentation of the progress toward management goals,
- detection of changes that may be an early warning of future problems or risks, and
- determination of the trend in pastureland condition (maintaining, declining, or recovering).

If the objective is to determine progress or trend, the sites that are representative of the pasture unit should be selected. If the objective is to provide an opportunity to modify management before problems occur, the sites that are most vulnerable should be selected. The detected changes must be real and must occur at a level of detection that allows land managers to recognize the problem and correct it before undesired and perhaps costly loss of soil quality occurs. Most degraded soil quality conditions can be reversed or even improved over the previous native site condition. For some conditions, such as content of organic matter, however, it may take several years or decades before the optimal level (at equilibrium) for the specific site can be restored. The monitoring plan should include the proper measurement frequency, which either limits or captures soil quality changes with time, as dictated by the specific objective, such as the need to adjust soil pH by applying lime.

For more detail about assessment and monitoring, see "Guidelines for Soil Quality Assessment in Conservation Planning" available at http://soils.usda.gov/sqi.

(Prepared by the Soil Quality Institute, Grazing Lands Technology Institute, National Soil Survey Center, Natural Resources Conservation Service, USDA; Agricultural Research Service, USDA)