Managing Sunlight In Pastures and Hayfields

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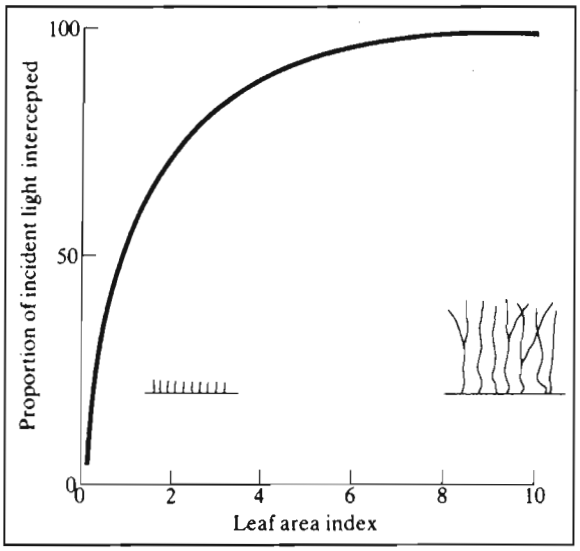
Since cattle producers are operating vast fields of leaf solar collectors to convert sunlight into sugars for forage production, it is important to think about how this factory can be best managed to maintain high production of nutritive forage over as much of the growing season as possible. Managing a pasture or hayfield to utilize sunlight effectively offers opportunities to improve efficiency of livestock productivity.

Sunlight utilization in a grass sward

A single grass leaf without any other leaves to cause shading normally has enough sunlight to capture sunlight at its full capacity. However, in a pasture or hayfield it is more likely that insufficient sunlight will be available for optimum photosynthesis in a large proportion of the leaves. Sunlight interception depends on the total amount of leaves in a sward, this being expressed as the leaf area index or LAI. The LAI is the surface area or layers of leaf per unit of ground. With an LAI of only 1 or less, as in an overgrazed pasture, there are not enough leaves to utilize the incoming light so it will be wasted and production suffers. As more layers of leaves develop, a higher proportion of the incoming sunlight is captured up to a point when more layers simply prevent light from reaching the lower leaf layers. For a cool season grass such as tall fescue or annual ryegrass, the maximum LAI or number of leaf layers is from 4 to 6 (see graph) which is a height of about 4 to 5 inches. For clovers, which have leaves displayed horizontally, shading is more of a problem so the maximum LAI or leaf layers is only about 3. For taller grasses with leaves held at an acute angle such as bermudagrass, light can penetrate deeper into more leaf layers so the LAI is about 7 while pearl millet is 10 to 12.

Proportion of incoming sunlight intercepted by a cool season grass (tall fescue) sward increases progressively up to an LAI of 4 to 6.

In practical terms, this means that accumulating excess amounts of leaf tissue beyond the maximum LAI will not increase light utilization by the total leaf area. Total light utilization and sugar production by the leaves reaches a plateau. However, leaves in the lower canopy with inadequate light continue to respire and utilize sugar so there is a decline in total energy production by a grass sward with excess leaf tissue. Also, the capacity of leaves to utilize sunlight declines as they age so that after 6 weeks they are generally non-functional as solar collectors and producers of sugars. Thus, maintaining too much ungrazed forage in a pasture results in respiration losses and less net production from the incoming sunlight. Similarly, when hay is cut at a very mature stage, there will be significant respiration losses by lower leaves in the canopy.



Influence of forage accumulation on tiller development

Tillers are essential for leaf production and regeneration of grass plants such as tall fescue. The tiller is a growing point encased in the sheaths of the leaves which grow from it, bearing its own root system, and having the capacity to develop new tillers from buds at the base of individual leaves. In grasses such as bermudagrass, new tillers arise from stolons (aboveground runners) or rhizomes (below ground horizontal stems) while in white clover they arise from stolons.

Tillers are relatively short lived and must be maintained by continuous replacement or overall forage production will decline. The production of new tillers, and consequently new leaves, depends on light reaching basal buds on the plant. Large amounts of accumulated forage result in shading and reduced tiller development. Thus, frequent removal of forage in pastures and hayfields favors tiller development.

Tiller production is affected by season of the year. Tiller development in tall fescue is at a maximum in early spring, falling during flowering and in summer, then increasing in autumn if water and nutrients are available. However, shading by large accumulations of forage over a considerable time period is the main cause of reduced tiller development. When hay is cut at an advanced stage of maturity such as spring tall fescue at mature seed stage or bermudagrass at 8 to 9 weeks, then tiller production is low and regrowth will be delayed. Hay cut at early maturity, such as bermudagrass at 4 to 5 week intervals, will result in more rapid regrowth. Pastures that are undergrazed in spring or summer will also have decreased tiller production. The solution is to graze off forage, allow light into the sward to generate new tillers and furnish new leaves capable of utilizing high levels of light.

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Influence of forage accumulation on nutritive quality

Young actively growing leaves are higher in protein and digestible energy than old dying or dead leaves. The decline in quality is greater with time in warm season grasses such as bahiagrass and bermudagrass than in cool season grasses. Grazing management that removes old growth and stimulates young leaf production will result in a higher quality pasture. Likewise, hay cut at an earlier stage of maturity will have a higher protein and digestible energy content and require less feed supplements for livestock.

Grazing or hay cutting management to best utilize sunlight

With an understanding of the relationship between light interception, forage growth, accumulation, and nutritive quality, it is possible to devise some methods of management. Forage defoliation should be frequent enough to remove the forage before growth declines occur from respiration losses and decay. Allowing a substantial amount of old grass to remain on a pasture over much of the grazing season will reduce tiller development and production of new leaves. Also, overgrazing should be avoided to leave sufficient leaf tissue for rapid regrowth to utilize sunlight.

A well managed continuously stocked pasture will do an excellent job of maintaining an abundant supply of tillers and new leaves. In this case, seasonal variation in forage growth rates need to be adjusted by changes in stocking rate. If rotational stocking is used, too long a rest period between grazings must be avoided or else excess forage accumulation may reduce tiller development and lower forage quality. Cutting hay at early maturity will not only improve sunlight utilization by leaves but also greatly improve nutritive quality of the hay.

The key to successful light utilization in a pasture or hayfield is attempting to maintain a high percentage of young actively growing leaves at all times. Old leaves are inactive and unable to utilize sunlight but continue to respire and waste energy. Dead leaves are unattractive to livestock as they select young green leaves while the older leaves decay. Basically, good grassland management is operating a highly productive leaf solar energy factory.