

IMPROVING ALFALFA'S LEAF-TO-STEM RATIO AND ITS IMPACT ON FORAGE QUALITY AND FIBER DIGESTIBILITY

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Plant breeders are continually striving to improve the forages we feed our livestock. These genetic improvements, combined with other factors, have increased milk production per cow in the U.S. by 50-60% in the last half century. This large jump in production has been aided by the utilization of higher digestible feeds and high-intake forages such as alfalfa.

Despite its reputation for high forage quality, alfalfa can vary from high to low quality for a variety of reasons. In an effort to maintain a consistent level of forage quality, there has been a concerted effort to understand what plant components influence these variations in forage quality.

In the case of alfalfa, the whole top growth is fed to the livestock, and the nutrient content and digestibility of its two components, leaves and stems, figure greatly in its feeding value at harvest. Any reduction in forage quality, separate from harvest-related losses, is for the most part attributed to two factors that are related to plant maturity at harvest. First is a variation in the leaf-to-stem ratio, and second is the increasing lignification of stem tissue during plant maturation.

The ratio of leaves to stems in the alfalfa fed to the livestock greatly affects its forage quality. Thus, the adage: more leaves = better quality; more stems = less quality. If we take a closer look at the chemical analysis of the plant top growth, it soon becomes apparent that most of the feeding advantage of alfalfa is found in the leaves and to a lesser extent in the stems:

- Leaves have 2-3 times the protein content of stems.
- Leaves contribute the majority of feeding value in an alfalfa forage sample.
- The leaf fraction of alfalfa accounts for up to 70% of the Relative Forage Quality (RFQ) of a forage sample.
- Neutral detergent fiber (NDF) of leaves is more digestible than stem NDF.
- With increasing plant maturity alfalfa, leaves remain relatively unchanged as far as digestibility is concerned; however, stems can become 30-40% less digestible.

Variation in the Leaf-to-Stem Ratio

The shift in the leaf-to-stem ratio of alfalfa as it matures is well documented. Immature alfalfa (prebud to bud) has the highest leaf-to-stem ratio (approx. 60/40), and as a result has the highest quality. The ratio approaches 50/50 at early flowering, and then reverses to having fewer leaves than stems (~40/60) at full maturity. This reversal of leaf-to-stem ratio adversely affects the feeding value of the forage.

The ratio of leaf-to-stem content in alfalfa is not constant, and leaf percentages can decrease as the crop matures. With the importance of leaf content on forage quality, knowledge of how the leaf-to-stem ratio changes with increasing plant maturity can be very important to the producer in obtaining optimal forage quality at harvest. The more alfalfa leaves a producer can capture at harvest the better. One tried-and-true method producers use to optimize leaf content has been to harvest the crop early (10% bloom). Early harvest sacrifices some yield but can improve forage quality in several ways. Immature alfalfa has a higher concentration of leaves, higher crude protein, and a higher level of dry matter digestibility (DMD). Prebud alfalfa often has CP >22, ADF <30, and NDF <40, where mature alfalfa can be significantly lower in quality with CP <17, ADF >36, and NDF >50.

Stem Lignification

The second factor that can affect alfalfa forage quality is stem lignification. As the plant matures the lignin content of the stems increases as a means of supporting plant functions and keeping the top growth from lodging. However, with this increase in lignin in the plant tissue also comes a decrease in fiber digestibility. This is reflected in the fact that acid detergent fiber (ADF) and neutral detergent fiber (NDF) values increase with plant maturity. The increase in lignin content in the plant tissue makes the forage more difficult to digest in the rumen, which in turn slows down passage and, thus, animal feed intake, all of which negatively affect milk production.

Recent Innovations Improve Alfalfa Forage Quality

Recent breeding efforts to improve forage quality of alfalfa have been directed at improving the leaf-to-stem ratio and improving the fiber digestibility of the stem.

In regard to the leaf-to-stem ratio, past improvements for leaf content involved an increase in the leaflet number and/or size of leaves (multi-leaf alfalfa). The most recent improvement in forage quality has been in the area of modifying the plant architecture throughout the plant canopy, including the lower stems, to significantly increase the overall leaf



percentage. This improvement, coupled with an increase in leaf disease resistance, has improved overall leaf content and the leaf-to-stem ratio at harvest.

The second breeding innovation has been the improvement of the fiber digestibility of alfalfa's stem component. A new class of alfalfa varieties with reduced lignin content is contributing to a significant improvement in whole plant fiber digestibility. Along with this improvement comes an increase in harvest flexibility. This allows the producer to harvest on their normal cutting schedule with better forage quality or have the option to delay harvest while maintaining acceptable forage quality and potentially increase yield.

Summary

Digestibility of alfalfa decreases as the plant matures, mainly due to two factors: an increase in stem lignin and a negative shift in the leaf-to-stem ratio. Until now the best remedy to overcome these factors was to shorten the harvest interval to improve forage quality.

The recent release of alfalfa varieties with improvements in plant architecture that improve the leaf-to-stem ratio or improvements in stem fiber digestibility are giving producers more tools to increase alfalfa's overall forage quality. Depending upon the amount of alfalfa in the dairy ration, these new innovations have the potential of increasing milk production 2-3 lbs/cow/day.



The alfalfa variety on the right has been selected for improved leaf-to-stem ratio while the conventional variety on the left has not.