# ASSESSING ALFALFA MATURITY FOR QUALITY PREDICTION

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## ABSTRACT

The maturity of an alfalfa crop at the time of harvest has the greatest impact on forage quality and is the variable most easily controlled by the grower. For many years, alfalfa maturity has been defined in terms of the percent bloom or the presence and length of regrowth buds. These estimates of maturity were associated with various quality parameters. Predictive equations for alfalfa quality based upon height of the most mature stem have shown promise as a rapid and inexpensive method of estimating alfalfa fiber components, but have not been as successful in predicting crude protein. Techniques have been developed to precisely quantify the stage of development of alfalfa for use in more accurate predictions of alfalfa quality. Models based on the maturity of the crop work well, since the cumulative effect of the environment on crop growth and alfalfa quality is expressed in a large part by its morphological stage of development.


**Key Words: Percent bloom, crown buds, regrowth, height, stage of maturity, stage of development, Mean Stage, MSC, MSW.**

## INTRODUCTION

Alfalfa is America's most important perennial forage crop. It is harvested several times each year, and fed as hay, silage, greenchop, or cubes. Alfalfa is also used for pasture and grown for seed production. A major limitation of alfalfa management in many areas is inadequate control of the nutritional quality of the feed. Forages are particularly difficult feeds to manage in the fields, and in ration formulation, because their nutritive value is highly variable.

In general, as an alfalfa plant matures and yield increases, there is a reduction in nutritional value. Quality declines quite rapidly after the onset of flowering because of the increasing proportion of lower quality, higher fiber stem tissue, and a reduction in the protein content as leaves drop. Within any regrowth interval, the trends in yield and quality can be modified by prevailing environmental conditions. The maturity of the crop at the time of harvest has the greatest impact on forage quality and is the variable most easily controlled by the grower. Management decisions based on alfalfa maturity have been shown to work well since the cumulative effect of the environment on crop growth and alfalfa quality is expressed in large part by its morphological stage of development. Cutting according to the stage of growth uses the plant as a harvest indicator and generally provides more consistent yield and quality among varieties and over years and locations.

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All aspects of management are built around the growth and development of the crop. A better understanding of growth and development is the key to better management. For years, researchers have studied ways to predict the quality of growing alfalfa as a step toward improving management.

## USING PERCENT BLOOM TO ASSESS MATURITY

For many years, the stage of alfalfa development has been estimated using the reproductive status of the most mature stems in the canopy. Thus, alfalfa is said to be at "late bud" or "early bloom". Although many alfalfa growers estimate the maturity of the crop as they are driving past the field in their truck, percent bloom can be more accurately determined by collecting a random sample of alfalfa stems from the field. To determine percent bloom, count the number of stems that have one or more blossoms and divide that number by the total number of stems collected in the sample. Several samples should be collected from each field to assess maturity. Data from numerous studies in the intermountain areas of California have shown that dry matter, crude protein, and total digestible nutrients were highest when alfalfa was harvested at 10 percent bloom.

## USING CROWN BUDS AND REGROWTH TO ASSESS MATURITY

While maturity of alfalfa is most commonly described by flowering stage, percent bloom is not always a good indicator of maturity. Insect damage, disease, and short photoperiods in the spring and fall can all affect the appearance of bloom. When making management decisions based on stage of maturity, it is best to also look at crown bud development, or use techniques that more precisely estimate maturity.

Presence of crown buds and length of regrowth are often used in addition to flowering stage to assess maturity. Consistent relationships between percent bloom and crown bud and regrowth characteristics have been observed over time and across locations. From samples collected throughout California, 16% bud alfalfa showed buds on 10-45% of the crowns. When alfalfa was at 10% bloom, regrowth averaged from 0.5 to 0.75 inch on 50-75% of the crowns, and with 50% bloom alfalfa, regrowth averaged from 1.25-2 inches on about 80% of the crowns. A general recommendation has been developed that ten percent bloom alfalfa is indicated when 60% of the crowns have regrowth buds which average 0.75 inch. Researchers suggested that since it appeared that crown buds and regrowth are related closely to stage of maturity, quality of alfalfa could be predicted by occurrence and height of crown buds and regrowth.

## USING HEIGHT TO ASSESS MATURITY

A further search for some physical measure of quality revealed that height of stand, irrespective of maturity stage, year, or cutting, was correlated with lignin content in hay (Meyer and Jones, 1962). The regression of height and lignin content at harvesting was highly significant. This was also true for height and protein content. The regression of an increase of 0.14 percentage units lignin for every height increase of 1 inch or a decrease of 0.47 percentage units protein for each height increase of 1 inch appears to be the best estimate for the state as a whole. The equations are as follows:

Estimated Lignin Content = 0.14(Height of Stand) + 3.24
Estimated Crude Protein Content = 34 - 0.47(Height of Stand)

More recently, predictive equations for alfalfa quality based on the tallest stem and the most mature stem of a sample were developed to estimate the NDF, ADF, and CP fractions of alfalfa (Owens, Albrecht, and Hintz, 1994). Separate equations were developed for use on samples obtained from 1) all cuttings, 2) first cutting, and 3) second and third cuttings in Wisconsin. For field evaluations, the predictive equations for alfalfa quality showed promise as a rapid and inexpensive method of estimating alfalfa fiber components, but not crude protein. The researchers are continuing to collect data to validate and refine their prediction equations.

## USING THE MEAN STAGE SYSTEM TO ASSESS MATURITY

In 1981, Kalu and Fick published a 10-stage classification system to define the stage of development of alfalfa. The system describes three vegetative, two bud, two flower, and three seed pod stages (Table 1). At a given time, individual alfalfa stems within a stand are at different stages of development. The mean stage method estimates the average stage of development of an alfalfa field, weighted for either the number (Mean Stage by Count, MSC) or dry matter contribution (Mean Stage by Weight, MSW) of the stems in individual stage categories.

**Table 1. Definition of morphological stages of development for individual alfalfa stems (Kalu and Fick, 1981).**

| Stage Number | Stage Name | Stage Definition |
|---|---|---|
| 0 | Early Vegetative | Stem length ≤15 cm; no buds, flowers, or seed pods |
| 1 | Mid-Vegetative | Stem length 16-30 cm; no buds, flowers, or seed pods |
| 2 | Late Vegetative | Stem length ≥31 cm; no buds, flowers, or seed pods |
| 3 | Early Bud | 1-2 nodes with visible buds; no flowers or seed pods |
| 4 | Late Bud | ≥3 nodes with visible buds; no flowers or seed pods |
| 5 | Early Flower | One node with one open flower; no seed pods |
| 6 | Late Flower | ≥2 nodes with open flowers; no seed pods |
| 7 | Early Seed Pod | 1-3 nodes with green seed pods |
| 8 | Late Seed Pod | ≥4 nodes with green seed pods |
| 9 | Ripe Seed Pod | Nodes with mostly brown mature seed pods |

To quantify alfalfa maturity, a representative sample of alfalfa is collected from the field. Individual stems are classified into one of the ten stages described by Kalu and Fick (1981). To determine MSC, the stems within each stage are counted and the result is computed using the following equation:

$$MSC = \sum_{S=0}^{9} (S*N)/C$$

where, S = Morphological stage number (0-9)
N = Number of stems in stage S
C = Total number of stems in the herbage sample

For example, if a sample of alfalfa had 10 stems in stage 3, 25 stems in stage 4, and 6 stems in stage 5, MSC would be calculated as follows:

$$MSC = \frac{(10 * 3) + (25 * 4) + (6 * 5)}{(10 + 25 + 6)}$$

$$= 160/41$$
$$= 3.90$$

Both MSC and MSW quantify morphological development of alfalfa. Most users will prefer MSC because it is less tedious. MSW can be calculated directly if the stems within each category are dried and weighed, or MSW can be calculated from MSC using this equation: MSW = 0.456 + 1.153 * MSC.

## PREDICTING ALFALFA QUALITY FROM MEAN STAGE OF DEVELOPMENT

It has long been known that the quality of alfalfa decreases as the crop matures, but the prediction of quality from stage of maturity has awaited precise definition of the mean stage of development. Some current alfalfa quality prediction models are based on the morphological stage of development of the crop (Kalu and Fick, 1983; Fick and Onstad, 1988). Models based on the maturity of the crop have been shown to work well, since the cumulative effect of the environment on crop growth and alfalfa quality is expressed in a large part by its morphological stage of development.

Consistent statistical relationships between MSW and quality components (ADF, NDF, ADL, CP, and IVTD) were reported by Kalu and Fick (1983). Their prediction equations for individual quality components were accurate across soil types, years, stand ages, and environmental differences existing within New York State. In all cases, results compared favorably with predictions utilizing growing degree days (GDD) or age. MSW integrated the environmental history of the crop into one numerical value that accounted for a substantial amount of the variability in alfalfa quality, making MSW the most robust field measurement available for the prediction of quality. MSW values are closely correlated with age and environmental factors related to nutritive value, and are more easily obtained that daily weather data for an entire growth period necessary to calculate GDD.

Fick and Onstad (1988) developed another set of equations for predicting changes in alfalfa quality from an extensive sampling of alfalfa. The data were collected in six states (NY, KY, NM, CA, GA, and WI) and included dormant, semi-dormant, and non-dormant alfalfa varieties. Predictor variables in the developed equations included age of the herbage, GDD, sum of the hours of daylight during the growing period, latitude, leaf percent by weight, MSC, and MSW. MSW and leaf percent were consistently identified as important in the prediction of quality, except in the case of prediction of lignin concentration, where GDD and leaf percent were the most influential variables. (This is not surprising since temperature is known to have a strong positive association with lignin formation.)

The Mean Stage method, if linked with computer models might use current price differentials between low and high quality alfalfa and enable growers to make a more informed judgement about the value of quality versus the value of yield in the field prior to each harvest. Data is currently being collected throughout California to further evaluate this technique for the prediction of alfalfa quality.

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