# ADAPTING CUTTING MANAGEMENT TO MARKET CONDITIONS

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## ABSTRACT

Profitability in producing alfalfa hay is mostly a function of yield. However, to the animal that consumes hay, forage quality is very important, especially in high-producing dairy cows where intake may be limited. Four factors change as the harvest date is delayed: 1) the physical yield, 2) the forage quality, 3) the value/ton, and 4) the harvest cost/A. How does a producer determine his best opportunity for profit given the dynamic changes in yield and quality in different environments and cuttings? The best strategy is to arm yourself with information such as past production and quality records, determine the current status of the forage crop, and predict the future status of the hay crop. Then you have information to optimize the yield versus quality curves and negotiate the best price for your crop. This paper provides some historical data from studies in Idaho—which may not fit your environment but provides examples to demonstrate a process.

**Key Words: cutting management, yield versus quality**

## INTRODUCTION

In negotiating a price, knowledge is your best friend so that you can determine profitability in producing a forage crop that is in demand.

Ultimately, the dietary requirements of the livestock being fed dictates how alfalfa should be harvested to obtain feed of a given quality. As alfalfa matures through several identifiable morphological stages (Kalu and Fick, 1981), feeding value declines with the rate of change being strongly influenced by temperature (Onstad and Fick, 1983). Thus, harvesting at more immature stages (vegetative to bud) dictates a shorter cutting interval (Putnam et al, 2005). Different environments provide different rates of change in yield and quality. My best advice is to learn and follow a process to predict the most profitable time to cut, given the market values and estimated rates of change in yield and quality. Proper marketing of alfalfa and other forages as a cash crop for animal feed requires a greater understanding of the relationship between forage yield and quality. My objective in this paper is to outline a logical procedure to adapt cutting management to market conditions.

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## RATES OF YIELD INCREASE AND QUALITY DECLINE

Premiums are paid for quality but some of the higher price for increased forage quality is offset by lower yields of hay cut early for the higher quality. The best alternative is difficult to assess since both alfalfa growth and change in forage quality vary considerably depending on environmental conditions, and because we have to forecast several variables.

Yield change per day around harvest time varies considerably and has ranged from 0 to 200 lbs per acre per day. The daily yield increase will be less in cool, cloudy weather, and if insects, disease or drought occur. It may be greater in periods of good moisture, sunshine and 75 to 85 degree weather.

***Experiment 1 Yield.*** Yield increased more rapidly at Kimberly, Idaho during the second and third harvest periods (180 lb/acre/day) than during the first harvest period, at 120 lb/acre/day (Martin et al., 2006; Table 1). The elevation at Kimberly is 3,800 ft above sea level and the temperatures are shown in Table 2.

**Table 1.** Linear regression equations describing trends for the change in yield and quality of alfalfa harvested initially at late vegetative stage, and every 5 days thereafter, to 20 days of maturity during three harvest periods in Idaho in 2005. Source: Martin et al. 2006.

| Cut | Yield (lb/A) | $R^2$ | NDFD (%) | $R^2$ | CP (%) | $R^2$ |
|---|---|---|---|---|---|---|
| 1 | y = 3990 + 120x | 0.84 | y = 55.8 - 0.3x | 0.70 | y = 26.8 - 0.2x | 0.97 |
| 2 | y = 1590 + 180x | 0.93 | y = 60.9 - 0.6x | 0.98 | y = 27.1 - 0.3x | 0.86 |
| 3 | y = 2110 + 180x | 0.95 | y = 54.3 - 0.5x | 0.98 | y = 28.2 - 0.4x | 0.92 |

NDFD = neutral detergent fiber digestibility
CP = crude protein
$R^2$ = the coefficient of determination, the proportion of variability in a data set that is accounted for by the statistical model. The closer to 1.0, the better the prediction.

**Table 2.** Air temperature monthly average, maximum, and minimum at the Twin Falls (Kimberly) AgriMet weather station in 2005. Source: U.S. Dept. of Interior, Bureau of Reclamation AgriMet Program: http://www.usbr.gov/pn/agrimet/index.html

| | Air temperature (degrees F) | | | | | | |
|---|---|---|---|---|---|---|---|
| 2005 | MAR | APR | MAY | JUN | JUL | AUG | SEP |
| Ave | 42.1 | 46.2 | 55.0 | 59.8 | 72.5 | 68.8 | 58.1 |
| Max | 52.6 | 56.5 | 65.7 | 72.9 | 80.9 | 77.0 | 70.4 |
| Min | 33.9 | 35.8 | 43.7 | 46.7 | 65.1 | 57.2 | 47.0 |

***Experiment 1 Forage Quality.*** Forage quality of first cutting in Idaho changed at a slower rate than in Wisconsin and Pennsylvania. In Idaho, acid detergent fiber (ADF) increased 0.2, 0.3, and 0.5 % per day during first, second, and third cuttings. In mid-western environments first cutting decreases about 5 pts relative feed value (RFV) per day, second cutting decreases 2 to 3 points per day and third and fourth cutting during the growing season decline 1 to 2 points per day. Thus environment—primarily climate components such as air temperature and amount of sunshine—can result in profound differences in forage quality change.

The rate of increase within harvests over all harvest periods differed for ADF and NDF in Idaho. ADF increased slower than NDF. Acid detergent fiber was not correlated to neutral detergent fiber digestibility (NDFD) at any harvest period in Idaho, ($R^2$ of -0.18, -0.08 and -0.13 for spring, early summer and late summer harvests). However, a significant negative correlation was determined at all harvests in Pennsylvania and Wisconsin. Therefore, determining the fiber digestibility (NDFD) is especially important in Idaho. The late fall growth may change little in forage quality during mid to late September and early October. Relative Forage Quality (RFQ) will change about the same as RFV on first cutting. In contrast to RFV, RFQ will show differences due to fiber digestibility in hot-season cuttings and decline about 3 points per day on $2^{nd}$, $3^{rd}$ and $4^{th}$ cuttings during the growing season.

***Experiment 2 Yield.*** The average yields and rate of change by cutting across 5 years are shown in Table 3. These are averages across all varieties which represent over 1,000 data points in the University of Idaho variety trials at Kimberly. Forage dry matter yields averaged 3.7, 2.2, 2.1, and 1.5 tons/acre for first, second, third, and fourth cuttings, respectively. Yield increased an average of 186 lbs/acre/day for first cutting. Second and third cuttings averaged about 134 and 124 lbs/acre/day, and fourth cutting averaged 64 lbs/acre/day increase.

***Experiment 2 Forage quality.*** The average of 5 years' forage quality data in University of Idaho variety trials is shown for first cutting in Table 3. These calculations assume that on average frosts occur until April 15, thus harvestable growth starts then and normally we need to take first cutting by May 24 to meet dairy quality hay criteria. Note the estimated beginning values for forage quality in Table 3. These are assumptions that we don't have much data to support, so be aware that these are more based on opinion than on data. These values are from grab samples of fresh alfalfa, so be aware there is minimal leaf loss compared to drying in a windrow and being baled for hay. Harvesting alfalfa as dry hay usually has a loss of 10 to 20% of forage quality because of lost leaves.

I estimate that crude protein declines by 0.15 percentage points per day to 21% CP on first harvest date. The fiber measurements increase at 0.19 percentage points ADF/day and 0.28 percentage points NDF/day. The total digestible nutrients (TDN) declines by 0.15 percentage points per day and relative feed value index (RFV) declines by 2.5 points per day for first cutting. Using these predictions, alfalfa hay would decline about 1 percentage point in CP and TDN in one week for first cutting.

**Table 3**. Estimated daily change in alfalfa forage yield and quality in alfalfa variety trials at Kimberly, Idaho.

| Year | Total Yield | Yield per cutting 1st | 2nd | 3rd | 4th | First cutting quality CP | ADF | NDF | TDN | RFV |
|---|---|---|---|---|---|---|---|---|---|---|
| | (Ton/acre) | | | | | (%) | (%) | (%) | (%) | index |
| Estimated beginning values | | 0 | 0 | 0 | 0 | 27 | 22 | 24.7 | 71.5 | 270 |
| Harvest averages | | | | | | | | | | |
| 2003 | 8.40 | 3.22 | 1.77 | 1.80 | 1.65 | 21.3 | 29.3 | 33.6 | 66 | 183 |
| 2004 | 10.20 | 4.02 | 2.78 | 2.28 | 1.12 | 20.0 | 29.7 | 36.9 | 65 | 166 |
| 2006 | 10.20 | 4.02 | 2.78 | 2.28 | 1.12 | 20.0 | 29.7 | 36.9 | 65 | 166 |
| 2007 | 9.61 | 3.30 | 1.84 | 2.26 | 2.21 | 21.7 | 28.4 | 35.4 | 66 | 176 |
| 2008 | 8.40 | 3.86 | 1.84 | 1.89 | 1.51 | 22.2 | 29.7 | 35.2 | 64 | 174 |
| Average | 9.36 | 3.68 | 2.20 | 2.10 | 1.52 | 21.1 | 29.4 | 35.6 | 65 | 173 |
| Average rate of change/day | | (lb/day) | | | | (%/day) | | | | (points/ day) |
| 2003 | | 174 | 122 | 112 | 67 | -0.15 | 0.20 | 0.24 | -0.16 | -2.4 |
| 2004 | | 201 | 155 | 111 | 51 | -0.19 | 0.19 | 0.31 | -0.15 | -2.6 |
| 2006 | | 206 | 155 | 143 | 52 | -0.18 | 0.20 | 0.31 | -0.16 | -2.7 |
| 2007 | | 174 | 123 | 146 | 85 | -0.14 | 0.17 | 0.28 | -0.13 | -2.5 |
| 2008 | | 175 | 115 | 108 | 69 | -0.11 | 0.17 | 0.24 | -0.17 | -2.2 |
| Average | | 186 | 134 | 124 | 65 | -0.15 | 0.19 | 0.28 | -0.15 | -2.5 |

## DISCUSSION

***Forage quality.*** Most studies have reported that the decline in alfalfa forage quality is more rapid in the summer than in the spring because higher temperatures increase the rate of morphological development (Marten et al., 1988). Results from Idaho and California support those findings, where both NDFD and CP concentration declined more rapidly during mid summer harvest periods than during the first (Table 1). However, every year has slightly different environmental conditions, indicating the need to carefully monitor changes in quality during all harvest periods.

***Forage quality index.*** Relative forage quality (RFQ) is an index used for legumes and grasses based on potential intake and fiber digestibility (Undersander and Moore, 2002). The index is used to price forage and to allocate forage to appropriate ruminant livestock performance levels.
In Idaho, RFQ dropped an average of 2.2, 5.3 and 3.3 units for spring, early summer and late summer, respectively. I highly recommend using the newer forage quality tests for NDFD and RFQ because they are more representative of the value to the animal than ADF, RFV, and especially TDN which is just calculated from ADF. The summative equation TDN as defined in the Nutrient Requirements for Dairy Cattle (National Research Council Dairy 2001) is: The sum

of digestible crude protein, fat (multiplied by 2.25), non-fibrous carbohydrates, and digestible NDF.

***Determining Hay Cutting Date.*** A spreadsheet to assist in determining hay cutting date is available from the University of Wisconsin (www.uwex.edu/ces/forage) to estimate optimum return based on yield and value of quality. Dairy quality hay in the West is generally considered to be 180 RFV (RFQ) or higher, in contrast to the Midwest where 150 RFV is used.

## A STRATEGY FOR CUTTING MANAGEMENT

There are several steps that should be taken to analyze for the best opportunity for profit:

1. Know your cost of production. It doesn't cost much more to harvest a 3-ton yield than it does a 1-ton yield. When you know your breakeven price, you know the price you must receive given the yield you can produce to meet the consumer's criteria.
2. Keep and review past harvest records. Know your historic yield and quality for typical harvest dates.
3. Monitor yield and vegetative stage. The alfalfa prediction stick is a good tool to accomplish this. Determine average height for the most mature stems in a field with the prediction stick and predict forage quality for that date.
4. Project the calendar date that will provide the forage quality required by the market criteria. You need to know the rate of change in yield and quality for that harvest period in your environment.
5. Adjust the projected cutting date to allow for the quality lost during harvest. For example, ADF usually increases 1-2% because of leaf shatter during hay harvesting.
6. Estimate the yield on that date.
7. Determine the projected profit or loss if marketed using that scenario.
8. Consider effects of early or late harvest on future cuttings and stand life.
9. Negotiate for the best profitability while balancing for stand life, reducing your risk, and establishing a long-term relationship with a consumer.

## CONCLUSION

The first harvest has the largest proportion of the annual yield, thus cutting management decisions on first harvest impact not only first cutting but subsequent cuttings. Harvest management considerations are thus most critical for the first harvest period. Predicting the quality of subsequent cuttings is more problematic, so cutting on a calendar basis may be the best strategy for those cuttings.

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