

**Northern NY Agricultural Development Program  
2005-2006 Project Report**

**The effect of cutting height on yield and quality of alfalfa in northern New York**

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## **Introduction**

The increased use of disc mowers, which are much less susceptible to damaged knives than sicklebar mowers, has resulted in many farmers mowing alfalfa fields considerably closer to the soil surface, less than 3" of stubble height. Decreasing the amount of stubble left in the field will increase yields. Canadian research reported that cutting 5 different varieties of alfalfa at 2-inch versus 4-inch increased yield in the first cutting by 588 tons/acres and by 172 tons/acre in the second cutting ([www.agr.gc.ca/pfra/csidc/alfacut\\_e.htm](http://www.agr.gc.ca/pfra/csidc/alfacut_e.htm)). Research done in Wisconsin also reported that for each cutting of alfalfa the forage yield increased as cutting height was reduced (Wiersma and Weiderholt, 2001).

However, since the increased yield is due to the harvest of more stem material and not more leaf material forage quality may decrease. The Canadian research reported a decrease in % protein as cutting height decreased ([www.agr.gc.ca/pfra/csidc/alfacut\\_e.htm](http://www.agr.gc.ca/pfra/csidc/alfacut_e.htm)). The Wisconsin researchers concluded that for each 1-inch reduction in cutting height forage quality decreased an average of 4 units of relative feed value (Wiersma and Weiderholt, 2001). Finally, some forage labs are reporting unusually high ash levels, possibly due to soil contamination from mechanical harvesting, are of concern.

## **Objectives**

To evaluate the current university recommendation to mow alfalfa at a 2-inch cutting height.

## **Materials and Methods**

Two studies were conducted to determine if harvesting alfalfa at 2-inch and 4-inch cutting height influences forage quality and yield. The first study involved the hand-harvesting of forage from a second year stand of alfalfa.

### *Hand harvest (Prior to field harvest)*

Three 24" X 36" areas were selected randomly within four plots and hand-harvested at 2-inch cutting height for first and second cuttings, while harvest of two areas provided adequate sample for third cut. Sward composition of the field was evaluated by separating forage species, drying and calculating sward composition based on dry weights. Two inches of stems were removed, weighed, dried and ground for analysis from harvested material. Remainder of harvested plants was weighed, dried and ground for analysis and this material was used to estimate 4-inch cutting height yield and forage quality. The 2-inch cutting height data was determined by mathematically calculating the yield and forage quality from the weighted average of 2-inch stems removed from the plants and the remainder of the plants for alfalfa and grass species. Alfalfa and grass species harvested were sent to a commercial lab for wet chemistry analysis (Cumberland Valley Analytical Services, Hagerstown, MD) for determination of NDF, ADF,

lignin, and ash. In vitro 24-h DM and NDF digestibility was evaluated using the Ankom system at the Miner Institute Forage Laboratory. Chemical and digestibility parameters of alfalfa and grass species were reported individually and as a combined value representative of field composition determined by calculating the weighted average of the alfalfa and grass.

#### *Mower Harvest*

A limitation of the hand-harvest trial was the lack of foreign material including soil and debris that may be inadvertently harvested when disc mowing. Therefore, a second study involved a replicated field harvest of alfalfa at theoretical cutting heights of 2-inch and 4-inch. Actual cutting height was determined after harvest by measuring stubble height from 15 random locations within each harvest plot. Yield was estimated and chopped forages were dried and ground for chemical analysis.

#### *Statistical Analysis*

Data were analyzed as a randomized block design using Proc GLM procedures of SAS (version 9.1).

## **Results and Discussion**

#### *Field Composition*

At first harvest there was 15.81% more grass in the plots than alfalfa (Table 1). However, at the second and third cuttings there were 49.43 and 40.61% more alfalfa than grass, respectively (Table 1). The difference in the composition of the plots is likely due to multiple environmental and management practices. Prior to the first cut total rainfall for May 2006 was 3.8” compared to an average of 2.5”. Additionally the average daily temperature was only 63.5°F. These environmental conditions favor grass over alfalfa growth. In the 2<sup>nd</sup> and 3<sup>rd</sup> cuttings the frequency of cuttings and leaving a stubble height of 2-inch may have caused reduced re-growth in the reed canary grass. In Minnesota when an alfalfa grass mixture was cut 3 times in a season the reed canarygrass was nearly eliminated at one location in the study (Sheaffer et al., 1990). Additionally Davis (1960) reported that close-cutting reduced both tillering and yield in reed canarygrass.

**Table 1. Forage composition of field during first, second and third cuttings (% wet weight).**

<b>Cutting</b>	<b>Alfalfa</b>		<b>Grass</b>		<b>Other</b>	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>
First	41.77	9.15	57.58	8.58	0.65	0.84
Second	74.41	5.74	24.98	5.64	0.61	0.51
Third	69.67	16.96	29.06	17.31	1.27	1.35

#### *Yield*

Expectedly, dry matter yield of hand-harvested alfalfa/grass was significantly higher for all 3 cuttings and for the combined yield at the 2-inch cut height (Table 2). The greatest yield difference was at first cutting when the 2-inch cut height yielded 0.3 T DM/acre more (Table 2). Yield of field-harvested material was unable to be calculated due to malfunction of a load cell in the scales used to measure crop yields in the field.

**Table 2. Dry matter yield of alfalfa/grass hand harvested at 2- and 4-inch cutting height as calculated for first, second and third cutting, and combined cutting yield.**

<b>DM Yield (T/acre)</b>	<b>2-inch</b>	<b>4-inch</b>	<b>SE</b>	<b>P</b>
First	1.99	1.69	0.02	0.001
Second	0.79	0.71	0.002	<0.001
Third	1.43	1.33	0.01	0.002
Combined	4.22	3.73	0.01	<0.001

*Forage Quality – Alfalfa/Grass Hand Harvest*

The calculated chemical analysis of all three cuttings of hand-harvested alfalfa/grass showed that the 4-inch cut was higher than the 2-inch in CP, ash, and DMd % DM (Table 3). The NDF, ADF, and lignin (% DM) were all lower in the 4-inch than the 2-inch (Table 3). Additionally, the NDFd (% original NDF) was higher in the 4-inch than in the 2-inch (Table 3). This was as expected for all measurements but ash. While the 4-inch was significantly higher in ash, which was not the expected result, the largest difference in ash for all three cuttings was only 0.12% DM in the third cutting (Table 3). Further no ash values for either cutting height were more than 9.08% DM (Table 3). These results indicate that differences in ash for cutting height will be due to equipment picking up soil, not the ash content contributed by the lower part of the plant. Overall, differences in chemical analysis were small and not biologically significant.

*Milk per acre*

When yield and quality of the alfalfa/grass hand harvested material was used in the Milk2000 model, the 2-inch cutting resulted in more milk per acre at each cutting and for the average of all three cuttings (Table 4). Despite the statistically significant differences in the chemical analysis of the two cutting heights, they are not biologically different. However, the higher yield/acre for the 2-inch cutting height will result in more milk per acre. Additionally, the largest difference in milk per acre was realized when the largest difference in yield was seen (Tables 2 and 4). Work done in Wisconsin using the Milk95 model reported similar results, with milk yield per acre increasing as cutting height decreased (Wiersma and Weiderholt, 2001). The Wisconsin researches concluded that totaled over the 3-cut season, milk yield increased by 900 lbs/acre with each 1-inch reduction in cutting height (Wiersma and Weiderholt, 2001).

**Table 4. Milk per acre calculated from Milk2000 for all three hand harvested cuttings and combined.**

<b>Cutting</b>	<b>2-inch</b>	<b>4-inch</b>	<b>Difference (2” – 4”)</b>
First	5448	4726	722
Second	2555	2355	200
Third	4293	4119	174
Combined	12596	11377	1219

*Forage Quality – Alfalfa and Grass Hand Harvest*

Alfalfa and grass that was hand harvested were chemically analyzed separately and had the same trends as the calculated hand harvested alfalfa/grass mix for all parameters except ash. Additionally, in the first cutting alfalfa the lignin (% DM) was not statistically significant, but the numerical difference was 0.23% DM higher in the 2-inch than the 4-inch cutting height (Table 5). However, the difference in the first cutting 2-inch and 4-inch cutting height for the

alfalfa/grass mix was 0.30% DM, which was statistically significant (Table 3). Again, the 4-inch cut was higher than the 2-inch in CP and DMd (% DM, Tables 5 and 6). The NDF, ADF, and lignin (% DM) were all lower in the 4-inch than the 2-inch (Tables 5 and 6). Additionally, the NDFd (% original NDF), was higher in the 4-inch than in the 2-inch (Tables 5 and 6). The separate analysis of the alfalfa and the grass for ash showed that there was no difference in the ash content of the grass for first and third cutting and in the second cutting the 4-inch was significantly lower than the 2-inch cutting height (Table 6). The alfalfa analysis for ash showed the same results as the alfalfa/grass mix, with the 4-inch cutting height always higher than the 2-inch cutting height (Tables 3 and 5).

*Mechanical (Field) Harvest – Actual Cut Height and Forage Quality*

The actual cutting height for the forage harvested using the conventional mower was not exactly 2 or 4 inches, but was significantly different for the first and second cuttings (Table 7). The actual difference between cutting height for the first cutting was 1.46 inches and 1.23 inches for the second cutting (Table 7). There was only a 1.0 inch difference in the actual cut height of the third cutting. This was likely influenced by a high rate of lodging due to a storm.

**Table 7. Actual cutting height of forage harvested using a conventional mower.**

Cutting	2-inch	4-inch	SE	P
First	2.94	4.40	0.10	0.002
Second	2.64	3.87	0.05	<0.001
Third	3.75	4.75	0.38	0.158
Overall	3.11	4.34	0.13	<0.001

The chemical analysis of the mechanically-harvested alfalfa/grass mix showed the same trends for all parameters except ash (Figure 1 a,b,c). The lignin (% DM) and NDFd (% of original NDF) were the only two parameters that were significantly different, with lignin lower and NDFd higher in the 4-inch (Table 8). The numerical difference between the 4-inch and the 2-inch cutting height at the first harvest was greater for the mechanical harvest for lignin and DMd (% DM), and NDFd (% original NDF, Figure 1a). The ADF and DMd (% DM) were significantly different in the second cut of the mechanically harvested alfalfa/grass with ADF lower and DMd higher in the 4-inch (Table 8). The numerical difference between the 4-inch and the 2-inch cutting height at the second harvest was greater for ADF, lignin, and DMd (% DM) and NDFd (% original NDF) for the mechanically harvested versus the hand harvested (Figure 1b). The chemical analysis of the mechanically harvested alfalfa/grass was not significantly different for the third cutting (Table 8). Again in the third cutting the numerical difference between the 4-inch and the 2-inch cutting height for ADF, lignin, and DMd (% DM) and the NDFd (% original NDF) were larger for mechanically-harvested versus hand-harvested forages (Figure 1c). Finally, the numerical difference in ash % DM was opposite in the mechanically harvested from the hand harvested, with the 4-inch having a lower ash value than the 2-inch (Figure 1 a,b,c). This was the expected result. The action of the mechanical cutting and chopping is adding some soil to the forage. However, the highest ash in the mechanically harvested alfalfa/grass was only 8.92% DM. An ash concentration less than 10% is considered acceptable for an alfalfa/grass mix.

The milk per ton, calculated from Milk2000, was 2615 and 2813 lbs of milk/ton for the average of the 2-inch and 4-inch mechanically-harvested alfalfa/grass. This indicates that despite the lack of significant differences in forage quality there is a difference in the potential milk yield from

the forage. However, without accurate yield data available for the mechanically-harvested alfalfa/grass the calculation of milk per acre is not possible.

## Conclusions

Overall, there is little or no difference in the quality of forage harvested when an alfalfa/grass mix is cut at 2 or 4 inches. There is an indication of a difference in the yield from the hand harvest data, with the 2-inch cutting height yielding more forage, as expected. More accurate data on yield from the field harvest of the two cutting heights is needed to determine the milk per acre. It appears that the decision of alfalfa/grass cutting height should be made based on field conditions, needs for forage, and grass species planted.

**Education and Outreach Plan.** Results of this research will be published in the monthly Miner Institute Farm Report, with readership of over 10,000. This newsletter is not copyrighted, and articles are often used by farm newspapers and county Cooperative Extension publications. Ev Thomas presented the results of this study at the 2006 Dairy Day held at Miner Institute.

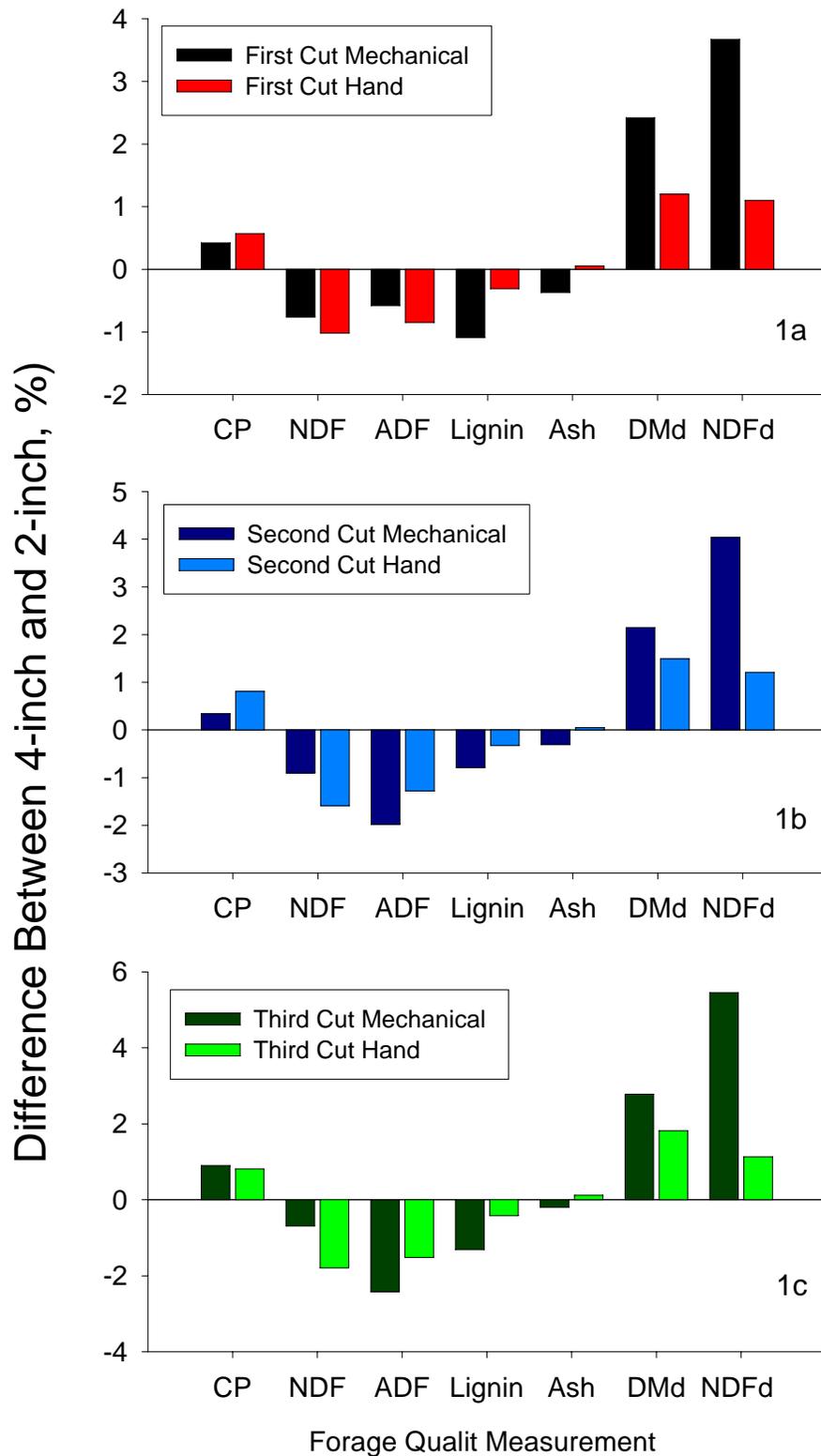
## References

Agriculture and Agri-Food Canada. 2003. Effect of cutting height on alfalfa yield and quality. [www.agr.gc.ca/pfra/csfdc/alfacut\\_e.htm](http://www.agr.gc.ca/pfra/csfdc/alfacut_e.htm).

Davis, W. E. P. 1960. Effect of clipping at various heights on characteristics of regrowth in reed canarygrass (*Phalaris arundinacea* L.). *Can. J. Plant Sci.* 40:452-456.

Sheaffer, C. C., D. W. Miller, and G. C. Marten. 1990. Grass dominance and mixture yield and quality in perennial grass-alfalfa mixtures. *J. Prod. Agric.* 3:480-485.

Weirsmas, D. W. and R. Wiederholt. 2001. Alfalfa cutting height to maximize forage yield and quality. University of Wisconsin Extension. [www.uwex.edu/ces/forage/wfc/proceedings2001/alfalfa\\_cuttine\\_height.htm](http://www.uwex.edu/ces/forage/wfc/proceedings2001/alfalfa_cuttine_height.htm).



**Figure 1 (a,b,c).** Difference in forage quality measurements of the 4-inch and 2-inch cutting heights for the mechanical and hand harvest.

**Table 3.** Chemical composition and digestibility of alfalfa/grass hay harvested at 2 and 4 inch cutting height.

Item	First Cut				Second Cut				Third Cut				Average			
	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value
CP (%DM)	16.16	16.73	0.02	<0.001	21.40	22.21	0.02	<0.001	19.07	19.88	0.02	<0.001	18.87	19.61	0.24	0.04
NDF (%DM)	55.92	54.90	0.03	<0.001	47.36	45.77	0.05	<0.001	43.56	41.77	0.21	0.009	48.95	47.48	0.44	0.03
ADF (%DM)	35.05	34.20	0.02	<0.001	30.34	29.06	0.04	<0.001	31.28	29.76	0.05	<0.001	32.22	31.01	0.20	<0.001
Lignin (%DM)	6.09	5.78	0.02	0.002	5.32	4.99	0.01	0.002	7.00	6.58	0.02	<0.001	6.13	5.78	0.07	0.002
Ash (%DM)	7.97	8.02	0.01	0.011	9.03	9.08	0.01	0.031	8.20	8.32	0.01	<0.001	8.40	8.47	0.05	0.30
DMd (%DM)	73.95	75.15	0.03	<0.001	82.21	83.70	0.04	<0.001	78.74	80.56	0.03	<0.001	78.30	79.80	0.24	<0.001
NDFd (% original NDF)	52.67	53.77	0.02	<0.001	60.56	61.77	0.03	<0.001	42.76	44.11	0.09	0.002	54.33	55.48	0.69	0.30

**Table 5.** Chemical composition and digestibility of alfalfa hay harvested at 2 and 4 inch cutting height.

Item	First Cut				Second Cut				Third Cut				Average			
	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value	2	4	SE	<i>P</i> -value
CP (%DM)	22.71	23.41	0.01	<0.001	20.42	21.45	0.01	<0.001	20.33	21.14	0.02	<0.001	21.15	22.0	0.15	<0.001
NDF (%DM)	41.24	39.74	0.04	<0.001	37.00	34.36	0.07	<0.001	37.63	35.40	0.08	<0.001	38.62	36.50	0.26	<0.001
ADF (%DM)	30.82	29.67	0.04	<0.001	29.71	27.42	0.06	<0.001	30.45	28.62	0.04	<0.001	30.33	28.57	0.23	<0.001
Lignin (%DM)	7.52	7.29	0.17	0.424	6.80	6.15	0.02	<0.001	7.71	7.14	0.02	<0.001	7.34	6.86	0.06	<0.001
Ash (%DM)	8.60	8.75	0.01	<0.001	8.11	8.29	0.01	<0.001	7.89	8.07	0.01	<0.001	8.20	8.37	0.06	0.073
DMd (%DM)	78.04	79.64	0.03	<0.001	78.74	81.21	0.08	<0.001	77.97	80.10	0.07	<0.001	78.25	80.31	0.18	<0.001
NDFd (% original NDF)	47.34	48.79	0.04	<0.001	44.20	45.85	0.03	<0.001	42.76	44.11	0.09	0.002	44.76	46.25	0.38	0.014

**Table 6.** Chemical composition and digestibility of grass hay harvested at 2 and 4 inch cutting height.

Item	First Cut				Second Cut				Third Cut				Average			
	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>
CP (%DM)	11.44	12.00	0.02	<0.001	22.19	22.86	0.02	<0.001	17.29	18.08	0.02	<0.001	16.97	17.64	0.40	0.247
NDF (%DM)	66.38	65.54	0.02	<0.001	54.84	53.86	0.02	<0.001	57.24	55.92	0.07	0.001	59.49	58.44	0.23	0.005
ADF (%DM)	38.06	37.38	0.03	<0.001	30.80	30.23	0.02	<0.001	32.40	31.62	0.07	0.004	33.75	33.08	0.18	0.016
Lignin (%DM)	4.91	4.75	0.03	0.036	4.27	4.18	0.01	0.001	5.18	5.04	0.01	0.005	4.79	4.65	0.09	0.325
Ash (%DM)	7.50	7.50	0.01	0.638	9.71	9.64	0.003	0.001	8.94	8.93	0.02	0.728	8.72	8.69	0.09	0.838
DMd (%DM)	71.07	72.05	0.02	<0.001	84.72	85.49	0.03	<0.001	81.01	82.28	0.07	0.001	78.93	79.94	0.24	0.009
NDFd (% original NDF)	56.55	57.36	0.03	<0.001	72.31	73.06	0.06	0.003	67.07	68.30	0.08	0.001	65.31	66.24	0.32	0.056

**Table 8.** Chemical composition and digestibility of alfalfa/grass mechanically (field) harvested at 2 and 4 inch theoretical cutting height.

Item	First Cut				Second Cut				Third Cut				Average			
	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>	2	4	SE	<i>P-value</i>
CP (%DM)	15.82	16.24	0.42	0.522	17.79	18.13	0.32	0.511	18.51	19.41	0.68	0.415	17.37	17.93	0.26	0.144
NDF (%DM)	58.08	57.32	0.25	0.120	44.39	43.49	0.26	0.092	45.86	45.17	0.35	0.261	49.44	48.67	0.21	0.02
ADF (%DM)	36.76	36.18	0.14	0.055	30.01	28.03	0.34	0.025	32.54	30.12	0.89	0.151	33.10	31.44	0.39	0.008
Lignin (%DM)	8.25	7.16	0.09	0.003	6.57	5.78	0.20	0.071	7.51	6.20	0.36	0.084	7.44	6.38	0.14	<0.001
Ash (%DM)	8.42	8.05	0.28	0.417	8.92	8.61	0.16	0.275	8.41	8.21	0.21	0.567	8.58	8.29	0.10	0.06
DMd (%DM)	68.71	71.13	0.56	0.055	78.21	80.36	0.44	0.040	77.52	80.30	0.80	0.091	74.81	77.26	0.35	<0.001
NDFd (% original NDF)	45.79	49.46	0.82	0.050	51.33	55.37	1.29	0.114	50.98	56.43	1.62	0.098	49.37	53.75	0.66	<0.001