Alfalfa Yield and Quality Relationships Within Individual Harvests

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Our improving knowledge of the relationship between alfalfa *yield* and alfalfa *quality* has greatly influenced when farmers harvest the crop.
Consider this **timeline** of how alfalfa harvest management has evolved through the years.

<table>
<thead>
<tr>
<th>Time frame</th>
<th>Farmer’s goal</th>
<th>No. harvests</th>
<th>Growth stage at harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920-1950</td>
<td>Persistence, yield</td>
<td>1 – 2</td>
<td>Full flower</td>
</tr>
<tr>
<td>1950-1960</td>
<td>Nutrient yield*, persistence</td>
<td>3</td>
<td>First flower</td>
</tr>
<tr>
<td>1970’s</td>
<td>Nutrient yield*</td>
<td>4</td>
<td>First flower</td>
</tr>
<tr>
<td>1980’s</td>
<td>Nutrient concentration**</td>
<td>4</td>
<td>Bud</td>
</tr>
</tbody>
</table>

* Total amount of nutrients harvested  
** Favorable percentage of nutrients in the plant  

*Sheaffer, 1990*
We know that:

When we give the plant more time to grow before harvesting . . .

. . . yield increases,
. . . but at the expense of feed quality.

When we cut the plant early . . .

. . . we capture a higher quality feed;
. . . but this is at the expense of total yield.
This previous study clearly shows . . .

. . . you get a greater monetary return (based on crop value) per acre of alfalfa with higher yields.

Undersander, 2001
But yield and quality are opposed:

As yield increases (green bars) . . .

. . . quality declines (orange line).

Quality measured as in-vitro dry matter digestibility (IVDMD)

Smith, 1960
Previous studies on the trade-off between yield and quality looked at the crop on an annual basis.
We conducted a study to find out:

1. What is the trade-off between yield and quality *during the growing season*? Does it vary from one cutting to the next?
We conducted a study to find out:

2. When does harvest management have the greatest impact on potential milk production?
Study conducted at 3 locations:

- South Central Idaho
- Central Pennsylvania
- South Central Wisconsin

Study conducted on 2005 crop.
We planted 3 different varieties at each location.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Source</th>
<th>Advertised traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affinity+Z</td>
<td>ABI</td>
<td>disease resistance, fall dormancy 4, full season, fast recovery, traffic tolerance</td>
</tr>
<tr>
<td>Standfast</td>
<td>CalWest</td>
<td>lodging resistance, fall dormancy 4/5, fast recovery (reach late bud 3 - 5 days faster)</td>
</tr>
<tr>
<td>WL-346</td>
<td>WL Research</td>
<td>insect/disease resistance, fall dormancy 4, fast recovery</td>
</tr>
</tbody>
</table>
We set up a detailed cropping schedule at each location with:

4 harvest periods

- Spring
- Early Summer
- Late Summer
- Fall

And five cuts for each harvest period (each cut 5 days later than the first).
Cutting dates for each harvest period

**Spring**
- May 11
- May 16
- May 21
- May 26
- May 31

**Early summer**
- Jun 18
- Jun 23
- Jun 28
- Jul 3
- Jul 8

**Late summer**
- Aug 4
- Aug 9
- Aug 14
- Aug 19
- Aug 24

**Fall**
- Sep 12
- Sep 17
- Sep 22
- Sep 27
- Oct 2
The results:

Yield was highest for the Spring harvest period in all 3 locations.

(Yield in this chart is for first cut in each harvest period.)

* No differences found among varieties.
The results:

Quality* was highest for the Spring harvest period for 2 of the 3 locations.

*Quality measured as Neutral Detergent Fiber Digestibility (NDFD) – the portion of the total NDF that is actually digested.

**No differences found among varieties
The results:

In Idaho, forage production was dependent on and maximized under irrigation beginning in early summer.

In Pennsylvania and Wisconsin, the greatest rate of DM production occurred in the spring or early summer due to optimum temperatures and moisture.

<table>
<thead>
<tr>
<th>Harvest period</th>
<th>Rate of DM production after vegetative stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb forage grown per day</td>
</tr>
<tr>
<td></td>
<td>ID</td>
</tr>
<tr>
<td>Spring</td>
<td>120</td>
</tr>
<tr>
<td>Early summer</td>
<td>180</td>
</tr>
<tr>
<td>Late summer</td>
<td>180</td>
</tr>
<tr>
<td>Fall</td>
<td>--</td>
</tr>
</tbody>
</table>
The results:

At all three locations, forage quality declined most rapidly in the early summer.

In Pennsylvania and Wisconsin, the decline in forage quality is slowest in late summer.

<table>
<thead>
<tr>
<th>Harvest period</th>
<th>% NDFD change per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ID</td>
</tr>
<tr>
<td>Spring</td>
<td>- 0.3</td>
</tr>
<tr>
<td>Early summer</td>
<td>- 0.6</td>
</tr>
<tr>
<td>Late summer</td>
<td>- 0.5</td>
</tr>
<tr>
<td>Fall</td>
<td>--</td>
</tr>
</tbody>
</table>
Another way to express the results is by using an index (Milk 2000) that combines forage yield and quality into a single term to estimate milk production.

Results are seen in the next 4 slides.
The results: **Spring harvest**
Lbs. milk / acre vs. alfalfa maturity

<table>
<thead>
<tr>
<th>Veg</th>
<th>Days after vegetative stage</th>
<th>Milk per acre (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>5000</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>10000</td>
</tr>
<tr>
<td>15</td>
<td>20</td>
<td>15000</td>
</tr>
</tbody>
</table>

Milk per acre plateaus approximately 10 days after vegetative stage.

**Idaho**

- Days after vegetative stage: 5, 10, 15, 20
- Milk per acre: 10000, 15000, 20000

**Pennsylvania**

- Days after vegetative stage: 5, 10, 15, 20
- Milk per acre: 5000, 10000, 15000
The results: **Early summer harvest**

Lbs. milk / acre vs. alfalfa maturity

Milk/acre plateaus after 10 days, similar to spring harvest, in PA.

Environments in ID and WI result in milk/acre increase due to increase in DM yield of crop.
The results: Late summer harvest
Lbs. milk / acre vs. alfalfa maturity

During this harvest, potential milk production continues to increase because DM is increasing while forage quality does not decline as rapidly as in early summer.

**Idaho**

- Days after vegetative stage: 0, 5, 10, 15, 20
- Potential milk production: 5000, 10000, 15000, 20000

**Wisconsin**

- Days after vegetative stage: 0, 5, 10, 15, 20
- Potential milk production: 5000, 10000, 15000, 20000

**Pennsylvania**

- Days after vegetative stage: 0, 5, 10, 15, 20
- Potential milk production: 5000, 10000, 15000, 20000
The results: **Fall harvest**

Lbs. milk / acre vs. alfalfa maturity

There was no fourth harvest in Idaho.

Potential milk production of alfalfa harvested in the fall is less predictable due to the relatively rapid decline in quality and the inconsistent effects of weather on yield.
Summary

1) Forage yield and quality are usually highest in the spring.

2) Under conventional management (no irrigation), forage yield increases and forage quality declines most rapidly as alfalfa matures during the spring and early summer.
Summary

3) Harvesting within 10 days after vegetative stage in the spring and early summer provides optimum milk production and dairy quality hay.

4) Harvest in late summer can be delayed because digestibility declines more slowly than in the spring and early summer.