Minimizing Ash Content of Forage

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The ash content of forage has been largely ignored. Ash is the sum of all minerals in the forage, determined by burning the sample and weighing the residue.

Failure to consider ash content of forage can lead to a serious overestimation of the value of forage since while ash provides some minerals it is largely silica and takes the place of nutrients on almost a 1 to 1 basis (each 1% ash is 0.98% less total digestible nutrients). Note as well that most ash is silica, thus it is unusable by animals. Ash is generally more than twice the sum of measured mineral contents.

Forage ash in forage comes from two sources:
1. internal, e.g. minerals like calcium, magnesium, potassium and phosphorus taken up by the plant root system and transported to the leaves and stems.
2. external, e.g. dirt, bedding, sand, etc. on the forage surface.

The average internal ash content of alfalfa is about 6 to 8% and of grasses is about 6%. Additional ash in a hay or silage sample is contamination with dirt, sand, etc. As shown in table 1, a summary of ash content of forage samples submitted to the University of Wisconsin Soil and Forage Analysis Laboratory, the average ash content of haylage is 12.3% and of hay is 10.3%. Assuming the haylage is mainly alfalfa and the hay has a higher percentage of grass, forage samples are averaging about 4% ash contamination from external sources. Note that some samples have been as high as 18% ash. This means the animals consuming this forage were eating almost 1 pound of dirt in each 5 pounds of hay or silage!

When estimating energy from ADF, the ash content is unseen.

In the past most estimated energy from the ADF content. This value contained significant (but not all ash), so the ash effect was not fully accounted for. Now most estimate energy from the following summative equation:

<table>
<thead>
<tr>
<th>Type</th>
<th>Statistic</th>
<th>% Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haylage</td>
<td>Average</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>5.7</td>
</tr>
<tr>
<td>Hay</td>
<td>Average</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Table 1. Ash Content of Forage Samples, UW Marshfield Soil and Forage Testing Laboratory

Total digestible nutrients (TDN) = NFC*0.98 + CP*0.93 + FA*0.97*2.25 + NDF * NDFD/100 – 7

NFC = non-fiber carbohydrates = DM - Ash - CP - EE - NDF, % of DM
CP = crude protein, % of DM
FA = fatty acids = EE - 1, % of DM
EE = ether extract, % of DM
NDF = neutral detergent fiber, % of DM
NDFD = (48 hr in vitro NDF digestion), % of DM

Ash content is used to calculate the non-fiber carbohydrates (NFC); it is obvious that each 1% ash is 0.98% less NFC (and therefore TDN).

While some minerals are necessary for the forage growth and may be beneficial to animals eating the forage, we want to keep the ash content to the minimum. I recommend a goal of 10% or less total ash.
Growers can do several things along each step of harvesting, storage and feedout to minimize ash:

- **Avoid harvesting lodged forage** - as dirt often sticks to the downed forage when the soil is wet. This can’t always be avoided but can be reduced by planting varieties that stand better and by harvesting early to reduce the potential lodging. Downed or flooded forage should be analyzed for ash and fed accordingly.

- **Raise the cutter bar of a disc mower** - raising the cutter bar lowers ash and raises forage quality while lowering the cutter bar results in greater yield. Each individual must decide on the tradeoffs they want to take but generally a cutting height of 3 inches for pure alfalfa and 4 inches for alfalfa-grass mixes seems best in most cases.

- **Use flat knives on the disc mover** – to pick up the least ash when mowing. Several disk knife types are available as shown in the picture. The flat knife at the left will pick up the least ash while the middle knife, at a 14 degree angle, will create some suction to pick up more downed hay and ash (when soil is dry). At right is a stone knife.

- **Keep windrow off the ground** – starting with a wide swath and placing the cut forage onto dense stubble will eliminate harvesting a layer of soil on the bottom of windrows.

- **Keep rake tines from touching the ground** – this can be done if the forage is on top of stubble and the ground is level. Wheel rakes tend to incorporate more ash because they are ground driven. When raising a cloud of dust while raking, we can be adding 1 to 2 percent ash to the hay.

- **Minimize moving hay horizontally** with a rake. It is better to move two swathes on top of a third in the middle rather than to rake all to one side.

- **Using a windrow merger** will result in less ash content since the windrow is picked up and moved horizontally by a conveyer rather than being rolled across the ground. Merging can result in 1 to 2% less ash in the hay or silage.

- **Store silage piles/tubes on concrete or asphalt** to minimize ash contamination. Silage can be removed with minimal dirt contamination when conditions are dry but dirt may be picked up, particularly with the silage when conditions are wet and it is muddy around the silage pile or tube.

There will always be some soil contamination of grass and legume hay or silage. However appropriate harvesting and storage management can reduce the ash content of the hay or silage. Anyone with 10% or less ash has done a good job of minimizing ash content of hay or silage.

A couple additional notes:

1) Total ash, NDF ash, and ADF ash are three different numbers. Total ash is the largest since the fiber extractions remove some of the soluble minerals.

2) Due to the variability of ash some nutritionists have recommended using fiber values that are ash-free and which is usually designated NDF$_{om}$ to indicate that the fiber is only organic matter.