Watch Your Ash

by Dan Undersander, University of Wisconsin

Until recently, not much attention has been paid to ash as the summative equation to estimate energy of forage has been more widely used. Now, instead of estimating energy from acid detergent fiber (ADF), most estimate energy from the following total digestible nutrients (TDN) equation:

$$TDN = NFC*.98 + CP*.93 + FA*.97*2.25 + NDF * NDFD/100 - 7$$

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 NDF

When estimating energy from ADF, the ash content is unseen. Ash content is now used to calculate non-fiber carbohydrates (NFC) and each 1% of ash is 0.98% less NFC (and therefore TDN). While some minerals are necessary for forage growth and may be beneficial to animals, ash content is best kept to a minimum because it provides no calories and, in fact, replaces nutrients.

Ash in forage comes from two sources: internal (i.e., calcium, magnesium, potassium, phosphorus) and external (i.e., dirt, bedding, sand). The average internal ash content of alfalfa is ~8%; in grasses, it is ~6%. Additional ash in a hay or silage sample is from external contamination. As shown in Table 1, a summary of the ash content of forage samples submitted to the UW 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 average about 4% ash contamination from external sources. Some samples have been as high as 18%. This means some farmers have fed almost 1 lb of dirt for each 5 lbs of hay or silage.

Table 1. *Ash content of forage samples.*

Type	Statistic	% Ash
Haylage	Average	12.3
	Maximum	18.0
	Minimum	5.7
Hay	Average	10.3
	Maximum	17.6
	Minimum	8.8

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 downed forage when the soil is wet. This cannot always be avoided but can be reduced by planting varieties that stand better and by harvesting early in spring to reduce potential for a wind storm knocking the alfalfa/grass down.

Use flat knives - to pick up the least ash. Several disk knife types are available as shown in the picture. The flat knife (left) will pick up the least ash while the middle knife, at a 14º angle, will create some suction to pick up more downed hay and ash particularly when the soil is dry.

Raise the cutter bar - to lower ash and raise forage quality. While lowering the cutter bar results in greater yield (research suggests alfalfa be cut as short as 1.5 in. for max. yield; each inch above this will result in 0.5 ton/ac less annual yield), forage cut low with a disc mower will have higher ash content when the soil surface is dry. Each individual must decide on the trade-offs in this process, generally a cutting height of 2.5-3 in. seems best in most cases. (If mixture includes smooth bromegrass, orchardgrass, or timothy, cutting height should be 3-4 in. to avoid shortened stand life.)

Keep windrow off the ground - by starting with a wide swath and placing cut forage on dense stubble to eliminate harvesting a layer of soil on the windrows. The wide swath also increases drying rate. Windrow should be high enough to be raked or merged without the rake touching the ground. Rake tines can be kept off the ground if the forage is on stubble and the ground is level.

Minimize moving windrows horizontally - to reduce external ash contamination. It is better to move 2 swathes on top of a 3rd swath in the middle rather than to rake all to one side.

Use a windrow merger - rather than raking. This will result in hay or silage with 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 1-2% less ash in the hay or silage. Wheel rakes tend to incorporate more ash because they are ground driven. Keep in mind, if a cloud of dust is raised while raking, 1-2% of ash is being added to the hay.

Custom harvesters may be an option - to consider if merged hay with lower ash content is desired since mergers are expensive and may not be economical for many farms.

Store bales off the ground - to minimize ash contamination during storage. Bales that are set on the ground pick up water

from the soil which can lead to molding. This molding process causes loss of TDN and increases the ash concentration. More importantly, the wet hay will pick up a layer of ash on the bottom if bales are sitting on the ground.

Store silage piles/tubes on concrete or asphalt - to minimize ash contamination during storage. The most common source of added ash in silage is from piles or tubes which do not rest on asphalt or concrete. Silage can be removed with minimal dirt contamination when conditions are dry; however, dirt may be picked up with the silage when conditions are wet and muddy.

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. Optimal ash content should be 1 or 2 % below the averages shown in Table 1. Producers who achieve <10% ash content have done a good job and have increased the hay or silage quality.