Hay Rake Impacts on Ash Content in Alfalfa Hay

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Ash is defined as total mineral content of forage and exists in two forms, internal and external. Internal is naturally occurring minerals found in plants, some of which have livestock nutritional value (i.e., calcium, potassium, phosphorus). On average, grass forages have 6% internal ash on a dry matter (DM) basis, while legumes have 8%. External ash is commonly associated with soil contamination and provides no nutritional value. Higher levels of ash content in forages (≥8% DM) are problematic, since external ash provides no nutritional value and may lead to reduced economic efficiencies. Previous research determined wide swaths, cutting heights ≥2", and flat knives on mowers resulted in harvested forage with less ash content. Since soil disturbance is possible during raking, this phase has the potential to affect ash content. Effect of raking on ash content has not been evaluated before this study. Research was conducted in Minnesota, Pennsylvania, and Wisconsin to evaluate four types of hay rakes and their contribution to ash content in alfalfa hay. A merger, rotary rake, sidebar rake, and wheel rake were evaluated at all locations during two cuttings in 2015 (Photos). Samples were collected during four phases of hay harvest: standing forage (Stand), post-cut (Mow), post-raked (Rake), and post-baled or chopped (Bale) and analyzed for ash content and forage nutritive values (Table 1). Hay rakes were adjusted according to manufacturer recommendations and run at a standardized range of speed, operating width, PTO or PSI at each site. Sidebar rakes were set to operate at ¼" above the field surface.

Table 1. Ash content collected during four phases of hay harvest.

		Stand	Mow	Rake	Bale	Stand	Mow	Rake	Bale
		First Cutting				Subsequent Cutting			
Minnesota	Merger	11.2†	12.8†	11.1[b]	11.4[b]	9.6†	10.6†	10.5[b]	11.3
	Rotary			13.6[a]	13.0[ab]			12.5[ab]	12.4
	Sidebar			13.5[a]	13.2[ab]			13.6[a]	12.4
	Wheel			15.3[a]	14.6[a]			13.8[a]	12.9
Pennsylvania	Merger	9.8†	10.2†	9.8[b]	9.8[b]	10.5†	11.0†	9.7[ab]	9.9
	Rotary			9.9[b]	10.5[ab]			9.9[ab]	10.0
	Sidebar			9.5[b]	9.8[b]			9.5[b]	10.2
	Wheel			10.6[a]	11.1[a]			10.0[a]	10.3
Wisconsin	Merger	9.4†	9.4†	9.0	9.2	10.4†	10.9†	9.9[ab]	9.8[ab]
	Rotary			9.7	9.3			10.0[ab]	9.7[ab]
	Sidebar			9.1	9.0			9.8[b]	9.5[b]
	Wheel			10.3	9.5			10.5[a]	10.3[a]

[a-b]Within each column, location and cutting, means without a common superscript differ. No superscript indicates no differences were observed. †Values represent the mean of samples (n=16) collected across the field.

Hay rake-type affected ash content post-raking at all site-cuttings except for first cutting in Wisconsin. The wheel rake consistently caused the greatest ash content post-raking, while the hay merger and sidebar rake caused the least. The rotary rake resulted in intermediate amounts. Results confirm the observation that different types of hay rakes result in different amounts of ash post-raking. Machine operation and settings can greatly impact ash content, including non-optimal ground speed, PTO speed, or height adjustment on rakes and merger pickups. Ensuring rakes are adjusted and operated at manufacturer recommendations will help reduce ash content.

Throughout the harvest process, crude protein ranged 20-24%, neutral detergent fiber (NDF) 37-48%, and NDF digestibility 39-53% on a DM basis. However, differences in forage nutritive value due to hay rake type were rarely observed and forage nutritive values remained consistent throughout the harvest process. First cutting alfalfa differed in relative forage quality (RFQ) post-raking where the hay merger and sidebar rake generated greater RFQ values (121-165) compared with the wheel rake (114-160; data not shown).

The effect of feeding livestock hay with higher ash content is not well understood, but excessive ash content could be a barrier to maximizing production, and may lead to sand colic and reduced absorption of nutrients in horses. In Minnesota first cutting hay, ash content was 14.6% using a wheel rake and 11.4% using a hay merger. If a farmer fed 25 lbs of alfalfa hay containing 14.6% ash (or 6.6% external ash), they would be feeding 1.6 lbs of soil contamination to their livestock compared with 0.8 lbs of soil contamination if the hay contained 11.4% ash (or 3.4% external ash) on a daily basis. Excessive ash content can be problematic when buying hay. Using the same values, 1 ton of hay containing 14.6% ash would contain 132 lbs of soil contamination compared with 68 lbs of soil contamination when the ash content was reduced to 11.4%. At an average cost of $150/ton, a hay buyer would be spending $9.90/ton on soil contamination of hay raked with a wheel rake compared with $5.10/ton on soil contamination with merged hay. Using a hay merger or sidebar rake to combine swaths resulted in less ash content compared to a wheel rake; however, rake-type rarely resulted in differences in nutritive value. In addition to wide swaths, cutting heights ≥2", and flat mower knives, the use of a hay merger or sidebar rake can be added to the list of best management practices to reduce ash content in alfalfa hay.

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