Soil Contamination, Leaf Loss, & Field Efficiencies with Crop Mergers

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High throughput capacities of modern forage harvesters that accommodate high yielding corn silage harvest require consolidation of lower yielding alfalfa for the production of haylage. This consolidation is accomplished by moving the mowed swaths of alfalfa to a centralized location, or windrow, using a rake or crop merger. Crop mergers utilize pick-up tines to lift the crop from the ground and place it on a conveyer belt where it is carried to the end of the machine and placed on the ground, typically on top of a singular mowed swath. Consolidation of mower swaths utilizing a 30" merger yields approximately a 70" mowed swath in a single windrow for the forage harvester to process.

Each operation performed to a crop provides an opportunity for a quality reduction with leaf loss and ash incorporation (soil contamination). Handling the crop by merging, as opposed to raking, aims to be gentler reducing leaf loss and soil contamination. A study conducted at the U.S. Dairy Forage Research Center assessed leaf loss and soil contamination at different cutting heights when the alfalfa was consolidated using a crop merger. The crop was merged at two different moisture contents (61.2% and 39.8% wet basis) and three different cutting heights (2, 3, and 4"). Soil contamination was quantified by comparing the ash content of mowed but un-merged alfalfa to the ash content of merged alfalfa windrow. Leaf loss due to merging was measured by collecting the detached leaves beneath mowed but un-merged alfalfa and comparing that to collected leaves beneath the merged alfalfa windrow.

Ash content at varying cutting heights was not statistically different beneath the mowed and un-merged swath but was statistically higher at 2" cutting height compared to that of the 4" cutting height. These differences were attributed to either the cutting operation or differences in plant composition at the different cutting heights. While the ash content did decrease at the higher cutting height, the decrease did not warrant changes in practices due to the statistically significant yield reduction (1.7 tons/ac) (Table 1).

Ash content and leaf loss were assessed at varying moisture contents before and after the merging operation. Ash content was not statistically different in un-merged alfalfa but was statistically higher at lower moisture content (Table 2). This higher ash content was attributed to the soil beneath the lower moisture content alfalfa being drier causing the pick-up fingers to incorporate more soil into the crop. Leaf loss was also higher at lower moisture content, but was within an acceptable range compared to previous research.

Table 1. Merged alfalfa yield and ash content response to varying cutting heights.

Cutting Height (inches)	Measured Stubble Height (inches)	Yield (tons/ac)	Ash Content in Mowed Swath (g/kg DM)	Ash Content in Merged Windrow (g/kg DM)
2	2.7_a	10.4_a	80.5_a	81.3_a
3	3.4_b	9.9_a	79.8_a	80.3_{ab}
4	4.3_c	8.7_b	79.2_a	80.0_b
LSD		0.3	2.2	1.1

$\alpha = 0.10$

Adapted from Digman et al. 2013. Crop Mergers: Management of Soil Contamination and Leaf Loss in Alfalfa. *Applied Engineering in Agriculture 29(2): 179-185.*

Table 2. Merged alfalfa leaf loss and ash content response to crop moisture content.

Crop Moisture (% w.b.)	Soil Moisture (% d.b.)	Ash Content in Mowed Swath (g/kg DM)	Ash Content in Merged Windrow (g/kg DM)	Leaf Loss (%)
61.2	26.9	79.1_a	79.9_a	1.2_a
39.8	23.8	80.8_a	80.3_b	2.2_b
LSD		2.2	1.1	0.5

$\alpha = 0.10$

Adapted from Digman et al. 2013. Crop Mergers: Management of Soil Contamination and Leaf Loss in Alfalfa. *Applied Engineering in Agriculture 29(2): 179-185.*

The last part of this study aimed to assess ash content, fuel use, and productivity of crop mergers in typical production settings. Similar methods for determining ash content were utilized as in previous parts of this study. Controller Area Network (CAN) data from the tractor was collected to gather Global Positioning System (GPS) location, travel speed, engine speed, and fuel rate of the operating machines. Fuel rates for the mergers assessed in this study (PTO driven) averaged 0.19 gal/ac. Engine speed for all operations remained below the tractor rated PTO speed. Fuel usage was kept low due to the fact that the power capacity of the tractor was higher than needed to accommodate the vertical draft (tongue weight) applied by the merger. Ash contents of the observed mergers were not statistically different and within expected ranges.

Crop mergers are used to consolidate mowed swaths of lower yielding alfalfa for processing through forage harvesters. Manipulation of the crop can reduce the quality by increasing leaf loss and incorporating soil (ash) into the crop. Higher cutting heights (4") decreased ash content in the merged crop but this reduction was offset by yield loss. Leaf loss and ash content was increased when merging the crop at a moisture content of 39.8% compared to merging the crop at 61.2%. Fuel usage of tractors operating mergers was lower than expected and was attributed to operating at lower than rated engine speeds for PTO operation.

The take home message is:

- Cutting alfalfa at or below 3" will maintain yield and ash content will not increase enough to offset yield losses at higher cutting heights;
- Merging at moisture contents near 60% wet basis will minimize leaf loss and soil contamination;
- Fuel usage can be minimized by operation below rated tractor PTO speeds, but PTO speeds should be maintained high enough that ground speed and field efficiency do not suffer.