ASSESSING KERNEL PROCESSING FOR HIGH-QUALITY FEED PRODUCTION

Brian D. Luck[1]

The extent of kernel processing has an effect on animal feed quality and machine fuel usage. Current methods require laboratory equipment which results in a delay between sampling and results. An image processing algorithm to determine the size distribution of corn kernel particles was developed. The algorithm was verified through analyzing images of particles with a known diameter. Kernels processes with 1, 2, 3, and 4 mm roll gap settings were analyzed and compared with the standard sieving method. This method can accurately determine the extent of processing in the field while adjustments to the harvest can still be made.

Methods:

Typical assessment of corn kernel particle size distribution is done by either sieving a sample, utilizing the Penn State Particle Separator, or visually assessing a known volume of chopped and processed corn silage (Figure 1). These assessment methods all have problems in that they are either subjective in their assessment methods or require assessment off-site and results do not return until after harvest has been completed.

Figure 1. Typical methods of assessing corn kernel particle size in chopped and processed corn silage. From left to right: 1) Ro-Tap™ Sieving, 2) Penn State Particle Separator, 3) One liter cups.

Chopped and processed corn silage samples were collected in a production corn silage field at the University of Wisconsin-Madison Arlington Agricultural Research Station (Arlington, WI) in 2015, 2016, and 2017. A self-propelled forage harvester (SPFH) (940 Jaguar, Claas North America, Omaha, NE) equipped with Shredlage™ crop processing rolls (Scherer Design Engineering Inc., Tea, SD) was used to harvest the standing corn. The theoretical length of cut was set to 1.9 cm and the machine was equipped with an 8 row gathering head. The crop processor rolls were set at 1, 2, 3, and 4 mm roller clearances. At each roller clearance setting 15.24 m of corn was harvested and blown on the ground in separate piles. Samples, approximately 600 mL per sample, of whole plant corn silage (WPCS) were pulled from each pile at random locations. Samples were placed in plastic sealable bags (Whirl-Pak 99100125, Nasco, Ft. Atkinson, WI) and were frozen within two hours of collection to maintain sample integrity and moisture content.

These samples were assessed with image analysis as wet (fresh), dry, and post sieved. Results were compared to sieved samples that were only assessed after the sample had been dried. The image analysis software utilizes an object of known size to identify the size of each pixel in the image and then measures the Maximum Inscribed Circle Diameter of each particle within the image (Figure 2). Table 2 shows the comparison of all sample states at each roller gap settings with the sieve results for samples collected in 2016.

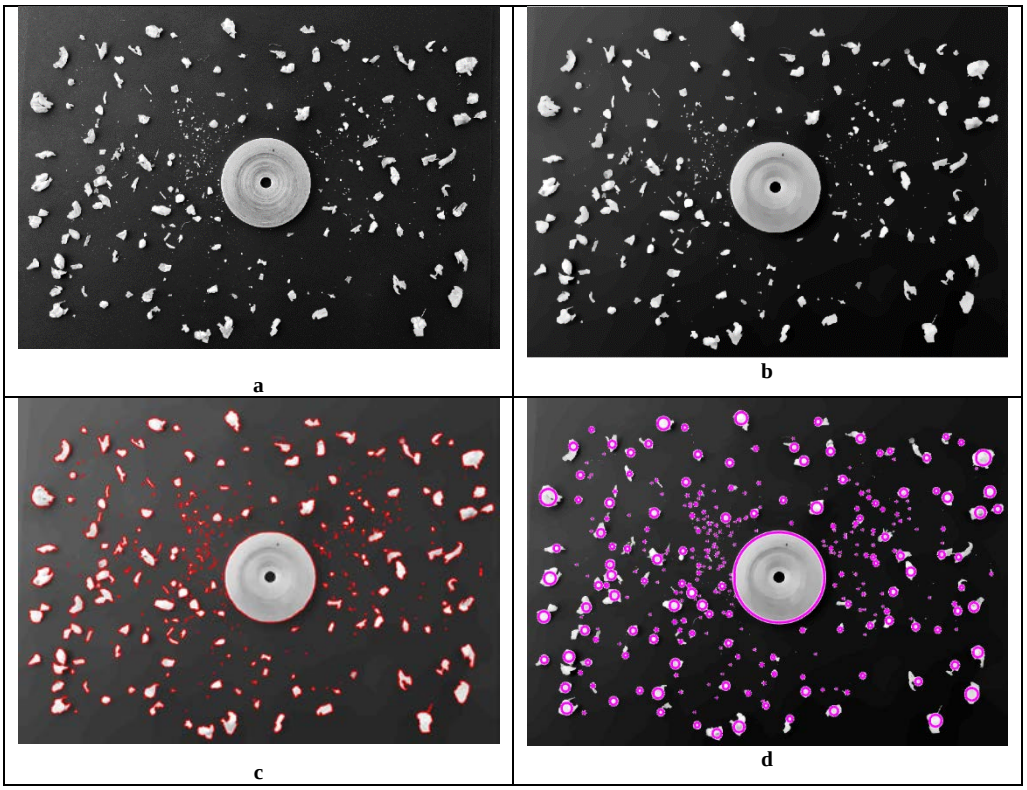

Figure 2. Example of the steps of the image processing algorithm (a) image is imported, (b) image was denoised, (c) contour of each particle was identified, (d) maximum inscribed circle of each particle was identified.

Table 1. Percent of particles smaller than 4.75 mm (Kernel Processing Score) by area (image analysis) or by mass (sieve analysis) for 2016 samples.

Processor Gap	Sample	Percent under 4.75 mm			
		Image analysis			Sieve
		wet	dry	sieved	dry
1	1	68.6	79.4	82.1	80.9
1	2	76.9	83.1	85.5	82.9
1	3	78.3	84.9	86.7	84.5
2	4	71.1	79.2	79.0	71.9
2	5	72.6	84.4	86.5	84.5
2	6	69.1	77.6	80.0	71.2
3	7	69.2	79.3	82.9	77.3
3	8	68.1	78.6	80.0	79.2
3	9	69.1	77.9	80.2	75.0
4	10	55.7	73.1	74.7	65.2
4	11	63.7	74.7	75.7	62.6
4	12	59.0	70.3	73.1	61.2

Results from this work have been translated into a smartphone application called SilageSnap (Figure 3). The application allows producers and custom harvesters to assess the particle size of the corn kernels within chopped and processed corn silage during harvest. An added step of hydrodynamic separation of the corn kernels from the plant material is required. Also, a U.S. coin will serve as the object of know size within the image and the photo must be taken on a dark background. The app is currently in the final stages of development and is slated for release in early 2018.

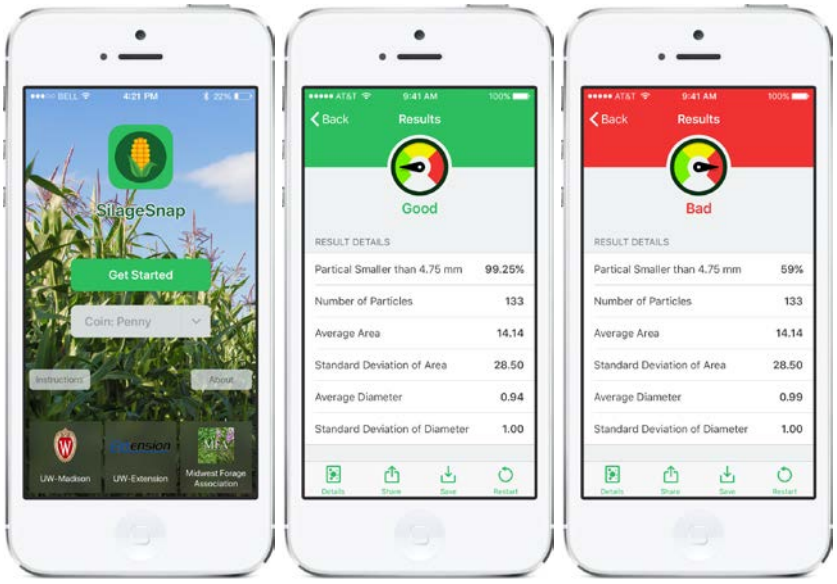

Figure 3. SilageSnap app for image analysis assessment of corn kernel particle size distribution in chopped and processed corn silage. From left to right: 1) Home Screen, 2) Good Results Screen, 3) Bad Results Screen.

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[1] Assistant Professor, Biological Systems Engineering Dept., 460 Henry Mall, Univ. of Wisconsin-Madison, Madison, WI 53706.