

Assessing Kernel Processing Score Using Image Analysis

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It is well documented that properly processing corn kernels in whole plant corn silage improves overall quality and digestibility. Studies suggest total digestible nutrients can be increased by as much as 5.3% over conventional silage. Other studies indicate milk yield can be maintained or increased even at greater theoretical lengths of cut with aggressive kernel processing. Ensuring kernel processors are performing the way we intend is vital for proper corn silage production.

Typically, the weather window for ideal corn silage harvest and processing is small. Custom harvesters and dairy farmers lack the time to send samples of processed corn silage to a lab for quality assessment and determination of kernel processing score (KPS) during harvest. The water separation method for removing plant material provides a visual assessment of the kernels during harvest but does not give a good indication of KPS. This method provides a check, but is a subjective assessment. Through funding provided by the MFA's Midwest Forage Research Program, image analysis is being assessed for KPS determination. This could lead to producers and custom harvesters having the capability of assessing KPS during harvest which could ensure silage quality.

Several corn kernel samples collected by Dr. Randy Shaver's lab from a survey conducted in 2014 were used in this research. These samples were dried and sieved in the traditional manner to quantify KPS for each. These samples were then analyzed for particle size distribution via image analysis. This initial assessment was designed to be a "best case" scenario for the image analysis in an effort to prove the concept. Three 10g sub-samples were collected from each sample. These sub-samples were spread evenly over a matte black surface and images of each were collected. An object of known size was placed in the picture, in this case a penny, in order to determine the width and height of each pixel within the image. This allows the results to be quantified in units of length rather than in number of pixels. Three different camera resolutions were assessed (8, 16, and 24 mega-pixels) to identify any differences between cameras in particle size distribution determination. These resolutions were chosen to represent the different camera resolutions available today. The lower resolution being a smart phone camera and the upper resolution being a high-end DSLR digital camera (i.e., the gold standard for comparison). Figure 1 (left) shows the original image of a corn silage sample taken with the 24 mega pixel camera. Once this image is loaded into the image analysis software, each particle is identified, including the penny. Figure 1 (right) shows the segmented image in black and white identifying each particle along with its major axis and minor axis length as well as area. From this analysis each particle can be placed in a group or bin to create a histogram. The histogram (Figure 2) quantifies the particle size distribution by counting the number of particles of similar size. This binning of different particle sizes provides a result similar to sieving.

Several more steps are required to assure image analysis is a suitable method for determining KPS, but the initial results are promising. The end goal of this research is to make determination of KPS available to producers and custom harvesters during the harvest process so that adjustments can be made to maintain silage quality. Nearly everyone has a camera on their phone. By utilizing image processing, producers and custom harvesters could have a means of assessing their KPS in the field without waiting for lab results to return. Ideally, this capability would be a machine mounted system to adjust the processor rolls on-the-fly, but there are several complications that will have to be overcome before that is possible. Isolating corn kernels in the stream of material passing through the harvester could prove challenging because the kernels are not the bulk of the material present. Utilizing a smart phone application will still require a sample to be gathered and kernels to be separated from plant material, but could give a "good" or "bad" assessment of KPS in the field. Further work is needed to finalize the methods for image processing determination of KPS and to begin development of the smart phone application.

Figure 1. Original image (left) and segmented image (right).

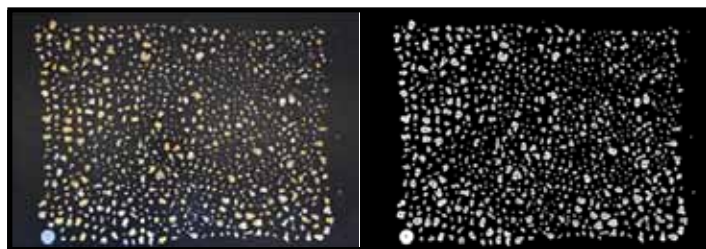


Figure 2. Particle size distribution from above images.

