MONITORING KERNEL PROCESSING DURING HARVEST

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Adjusting machinery settings is a simple method producers can use to improve forage quality. The cutterhead and kernel processer roll clearance on the combine affect the level of kernel processing which, along with other factors, determines the quality of the silage. Researchers at the University of Wisconsin-Madison found that smaller kernel size can make starch utilization in dairy cows more efficient, which can lead to increases in milk production (Ferraretto et al, 2013). Many steps can be taken during the harvest process to ensure that the corn silage is being optimally processed.

It is recommended the gap between the kernel processor rollers should be set to 1-3 mm (about the thickness of a dime) and the theoretical cut length set to 19 mm (Shinners et al., 2000). Researchers at the University of Wisconsin-Madison found that these settings resulted in improved dairy cow lactation without placing undue power requirements on the forage harvester. However, monitoring the kernel processing score (KPS) and recording actionable data in the field is the best way to determine if the harvester settings are appropriate and to identify any trends. Making adjustments to the settings each day can help to ensure uniform quality throughout the harvest.

Laboratory methods for determining level of kernel processing

The Ro-Tap sieving system is the standard laboratory method for determining the KPS, which is a measure of the level of kernel processing. The sample is dried and passed through progressive sieves to determine the percentage that can pass through a 0.187-inch (4.75-mm) screen:

- Optimally processed corn silage- 70% of kernels pass through the screen
- Adequately processed corn silage- 50% to 69% of kernels pass through the screen
- Inadequately processed corn silage- less than 50% of kernels pass through the screen

Laboratory analysis is key for ensuring a balanced Total Mixed Ration. However, sending off samples for analysis does not allow for adjustments to the harvester in the field.

Figure 1: Image of the Ro-Tap sieving system used in the laboratory analysis of kernel processing.

Field methods for determining level of kernel processing

Some of the most well know methods for assessing kernel processing in the field are the Penn State Particle Separator (Heinrichs,

2013), the water separation method (Shinners and Holmes, 2013), and the visual inspection method.

The Penn State Particle Separator (PSPS), along with an accurate scale, is typically used to determine the particle size in silage before feeding (for more information http://extension.psu.edu/animals/dairy/nutrition/forages/forage-quality-physical/separator). Three or four stacked trays are used to separate the particles in the sample based on their size. The sample is placed in the top box, with all boxes stacked, then the box stack is shaken by hand 40 times at a rate of approximately one shake per second. The amount of silage in each tray, by weight, is then used to determine the distribution of particles in the sample. This is similar to the laboratory method, making it a powerful metric in the field. It is important to note, however, that this method can be sensitive to the rate of shaking and moisture content of the sample.

Figure 2: Image of the Penn State Particle Separator for determination of particle distribution in silage samples.

The visual inspection and water separation methods use the number of whole kernels within a 1-quart sample as an indication of the level of kernel processing. If more than one whole kernel is found per quart sample, the kernel processing is not optimal. This method is useful in spot-checking the combine settings between more thorough analyses to determine the kernel size distribution. The steps for the water separation method are as follows (see the following link for a more detailed description and photographs of the process: http://fyi.uwex.edu/forage/making-sure-your-kernel-processor-is-doing-its-job/):

a. Fill a dishpan (or similarly sized container) about ¾ full with water
b. Place the representative forage sample in the container
c. Gently stir the material, for about a minute, to separate the stover from the kernel. The stover will float while the kernel will sink.
d. Skim the stover from the surface using your hands or a strainer
e. Slowly pour the water from the dishpan to ensure the kernels remain in the dishpan

Figure 3: Image of cups used for the visual inspection method to determine extent of kernel processing.

Image processing for determining level of kernel processing (SilageSNAP)

With a smart phone or tablet, dishpan, coin, and sheet of black construction paper, you can determine the kernel processing score in

the field or at the storage site. The kernels must first be separated from the stover and then an image is taken of the kernels along with a coin. The software in the newly developed mobile application SilageSNAP filters the photo to make the kernels stand out, detects the edge of each kernel, finds the coin at the center of the photo to serve as a scale, and determines the size of each kernel in the image (figure 4). This method results in recordable data that can be used to gain insight into trends between fields and to potentially spot kernel processor maintenance and wear issues.

2. Collect representative forage sample (about 1-2 handfuls), at least once per field. It would be best to collect several handfuls, mix them, and then collect 1-2 handfuls from the larger sample.
3. Use water separation method described previously to separate stover and kernel in the sample.
4. Place a coin (penny, nickel, dime, or quarter) at the center of a dark, matte background such as a sheet of construction paper.
5. Pat kernels dry gently then lay kernels out in a single layer around the coin, forming a rough rectangle. Make some effort to ensure particles are not touching (figure 5a).
6. Take a picture using the application. Try to align the camera directly over the kernels, parallel to the black surface.
7. Let the application determine kernel size distribution (figure 5b and 5c).
8. Make any needed adjustments to the kernel processing attachments.

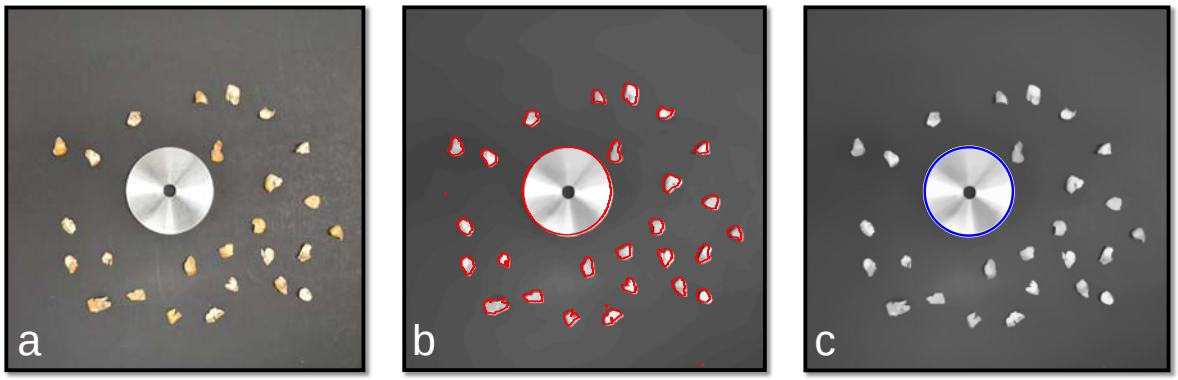

Figure 4: Example of an image analyzed for kernel size. The image is converted to grey scale, the edges within the image identified (red), and the coin identified and removed from the analysis (blue).

How to interpret results

Results of the image processing application and the PSPS method can be used to determine if the forage harvester settings are appropriate each morning. The image processing application will display the KPS and a histogram of particle size (figure 6). A worksheet can be used to analyze the results of the PSPS to determine the particle size distribution. If 70% of the kernels are smaller than 0.187 inches in diameter, the kernel processing rolls are set to an appropriate gap. If fewer than 70% of the kernels are smaller than 0.187 inches in diameter, the kernel processing roll gap should be reduced. The

roll gap should be between 1-3 mm (0.04-0.12 inches). This can be measured using a dime, nickel, or pocketknife, which are all about 1-3 mm in thickness. The setting can then be spot-checked using the visual inspection or water separation method throughout the day. Also, keep in mind that processing kernels too finely can cause wear on equipment and increased fuel usage.

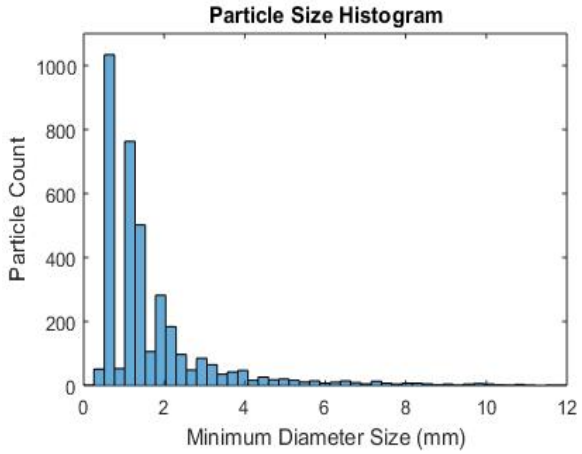

Figure 5: Example results of kernel distribution analysis.

Best practices for determining level of kernel processing

All of the presented methods can be used in conjunction to optimize kernel processing. The Penn State Particle Separator and the image processing method could be used each morning to provide actionable data about particle size distribution of the whole forage and kernels, respectively. Visual inspection or water separation can then be conducted one or more times per day, especially if field conditions change, to spot-check the settings. In addition to field methods, samples should be sent for laboratory analysis. The time invested in ensuring optimal kernel processing will yield benefits in the digestibility of the resulting silage.

References

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