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Machine Vision Method of Forage or Biomass Particle Size and Size Distribution



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1 Scope and Purpose

1.1 The purpose of the Standard is to define a test and analysis procedure to determine particle dimensions and particle size distribution (PSD) based on particle length for chopped forage, ground biomass, or other particulate materials using the machine vision method. The developed methodology (i) uses an image of the particulate material, obtained using a document digital scanner or digital camera, processes through an image processing system (Fiji/ImageJ) to measure basic particles' dimensions, and (ii) derive other properties, calculate their geometrical volume (in lieu of particles mass), analyses the PSD with a statistical computing programming language (R), and outputs results in textual and graphical forms.

1.2 Various size parameters (e.g., minimum, maximum, mean, standard deviation (STD) of length, width, aspect ratio, cumulative undersize dimensions, etc.), area and volume (total, minimum, maximum, and mean) as well as PSD parameters (e.g., uniformity index, size range variation coefficient, relative span, coefficient of uniformity, etc.) of particulate samples are determined.

1.3 The determined PSD results can be used to evaluate forage and biomass harvesting and processing equipment variables and to define the chopped particle length, fineness of ground biomass, and counting of sample particles. The procedure will work both for fresh (forage) and dried particulate material. The procedure can be readily extended to other particulate materials such as food grains, feed, minerals, or any granular free-flowing material.

1.4 This Standard is based on and compatible with ANSI/ASAE S319.4 and S424.1 and related ISO standards.

2 Normative References

The following two stand-alone computer software (Fiji/ImageJ and RStudio/R) that are well-known, both open-source and free to use, are indispensable for the application of this software-based standard. All relevant software download information for use with this standard will be found at <https://asabe.org/S631software>.

2.1 Fiji: For the image processing part of the methodology, Fiji or ImageJ, an open-source image processing software was used. Fiji (expanded as "Fiji is Just ImageJ") and ImageJ are essentially the same software but have different features, and this standard uses Fiji as the default system. Fiji can be freely downloaded and installed as a desktop integrated development environment (IDE). Alternatively, ImageJ (both desktop IDE and online platform) will produce similar results.

2.2 RStudio and R: For the PSD analysis part of the methodology, RStudio, an IDE of "R" an open-source statistical computing and graphics programming language was used. To utilize RStudio on a local computer, the base R software should be installed first. The R base interpreter software can be freely downloaded and installed. Even though it is possible to directly work with R, it will be convenient to use RStudio IDE, which this standard uses as the default system.