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# *Short Communication:* Prediction of Mean Particle Size and Proportion of Very Long Fiber Particles from Simplified Sieving Results

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## ABSTRACT

Mean particle size of alfalfa silage and corn silage can be predicted based on material retained above a screen with square-hole diagonal of 9 mm. The regression equation is mean particle length (mm) = 1.16 + 13.00 × cumulative fraction of as-fed mass trapped on or above the 9-mm screen; $r^2 = 0.89$. For mixed rations, the intercept was 0.54 and the slope 11.84, with $r^2 = 0.78$. Using data from the screen with a 5.6-mm diagonal also provided reasonable estimates of mean particle size.
(**Key words:** particle size, forage length)

Providing adequate physically effective fiber in diets fed to lactating cows is important for maintaining cow health, optimum rumen function, and milk fat yield; the physical effectiveness of a diet can be determined by the rumination time resulting from ingestion of a given feed (Mertens, 1997). The concept of physically effective fiber has been suggested as a way to incorporate data for dietary particle size based on mass distribution with the chemical NDF content of the whole diet to predict the physical effectiveness of the diet (Mertens, 1997). Recently, mean particle size has been shown to be a good predictor of physical effectiveness even when diets were constructed to have similar mean particle lengths but different particle distributions (Leonardi et al., 2005). Various methods exist to determine particle size of feeds and mixed rations and these techniques vary in screen design and number of screens used. Using a larger number of screens should increase the accuracy of determining mean particle size. However, NDF is not distributed identically with mass (Kononoff et al., 2003). It may be more useful to have the actual distribution of NDF, but as the number of screens used increases, this combined chemical and physical analysis becomes expensive. Such would be the case in research trials where orts would be analyzed, as well as in field applications in which analysis of multiple subsamples might not be cost-justified. The purpose of this investigation was to measure the ability of single-screen discrimination to predict mean particle size as determined by a 6-screen separation and to provide a regression equation that relates the two. If the number of physical samples can be reduced with little loss of information about the purely physical aspects of the feed, it may allow more detailed chemical analysis which may be more useful in predicting animal response. An additional aspect of providing adequate physically effective fiber to the cow is the tendency for some cows to sort against extremely long fibers. The amount of very long fibers is determined by the 6-screen separation used in this paper, but is not available from commonly used portable screens. In this paper, we present information showing the relationship of these very long particles to measured mean particle size.

The data analyzed in this report consisted of sieving results obtained by Dairyland Laboratories (Arcadia, WI) on 77 corn silage, 98 alfalfa silage, and 569 mixed ration samples. The samples were received from across the United States and Canada from September 2001 through May 2004. The majority of samples (approximately 60%) came from Wisconsin, Minnesota, Illinois, and Iowa; however, in 2004, samples were received from 42 states and 4 Canadian provinces. The apparatus used and the method of calculation of mean particle size and standard deviation for each sample were as described by the American National Standards Institute (ANSI, 1993). Particle size of the material retained

**Table 1.** Univariate statistics (mm) for the alfalfa silage, corn silage, and mixed ration samples analyzed.

| | Mean | Minimum | Maximum | SD |
|---|---|---|---|---|
| Alfalfa silage | | | | |
| Mean particle size | 7.75 | 3.30 | 14.10 | 1.74 |
| Particle size SD | 2.38 | 1.87 | 3.15 | 0.27 |
| Corn silage | | | | |
| Mean particle size | 9.43 | 5.89 | 13.03 | 1.37 |
| Particle size SD | 2.21 | 1.81 | 3.24 | 0.21 |
| Mixed ration | | | | |
| Mean particle size | 5.23 | 3.03 | 11.83 | 0.94 |
| Particle size SD | 2.99 | 2.15 | 4.30 | 0.20 |

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**Table 2.** Regression statistics for mean particle size (dependent variable) vs. cumulative fraction of feed on 9- or 5.6-mm screens (independent variable).

| | Intercept (SE) | Slope (SE) | Root mean square error | $r^2$ |
|---|---|---|---|---|
| Corn silage, 9 mm | –0.11 (0.50) | 14.86 (0.78) | 0.57 | 0.83 |
| Corn silage, 5.6 mm | –9.77 (0.89) | 23.47 (1.08) | 0.51 | 0.86 |
| Alfalfa silage, 9 mm | 1.28 (0.26) | 12.89 (0.50) | 0.62 | 0.88 |
| Alfalfa silage, 5.6 mm | –6.28 (0.70) | 18.89 (0.94) | 0.77 | 0.81 |
| Combined silage, 9 mm | 1.16 (0.20) | 13.00 (0.35) | 0.61 | 0.89 |
| Combined silage, 5.6 mm | –7.42 (0.50) | 20.51 (0.64) | 0.68 | 0.86 |
| Mixed rations, 9 mm | 0.54 (0.11) | 11.84 (0.27) | 0.44 | 0.78 |
| Mixed rations, 5.6 mm | –1.45 (0.12) | 11.98 (0.21) | 0.36 | 0.85 |

on the top screen was defined as 48 mm for all samples. Each sample was sieved one time only resulting in values for fractions retained on each screen and a calculated mean particle length for each sample. Univariate statistics for the mean particle length and standard deviation of the particle size distribution for this collection of feeds are reported in Table 1.

Simple linear regression was conducted using Proc GLM (SAS Institute, 1998). Mean particle length was considered as the dependent variable regressed against cumulative as-fed weight contained on or above the screens with diagonal openings of either 18 mm (f18), 9 mm (f9), 5.6 mm (f5.6), or 1.65 mm as a fraction of total as-fed mass. Regression analysis revealed that the 9- and 5.6-mm single-screen data were most useful in predicting mean particle size (Table 2, Figures 1 and 2). Quadratic terms were tested, and although these were occasionally significant, they did not raise the $r^2$ value by more than a few hundredths in any case. All other single-screen determinations gave $r^2$ values below 0.67.

Residual plots (Figure 3) indicated that the largest outliers from the regression are likely to be those where the actual mean particle size exceeds the estimate. There were only 3 observations (2 corn silage, 1 mixed) in which the actual mean particle size was more than

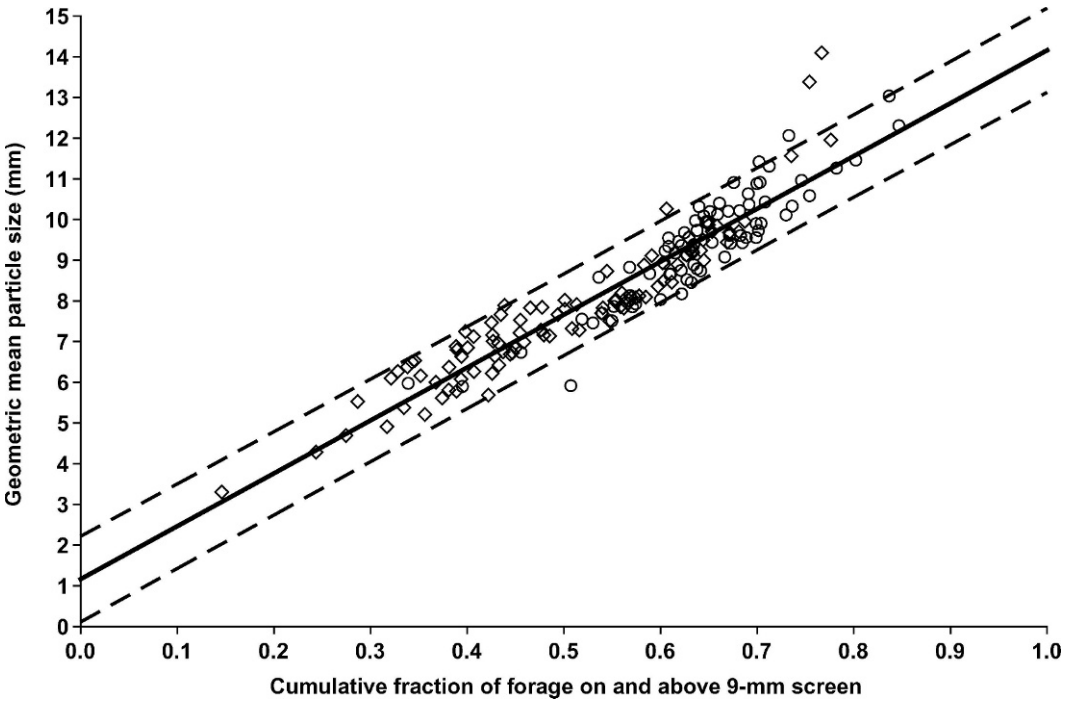


**Figure 1.** Mean particle size of forages calculated from a 6-screen separation vs. fraction of forage retained on or above the 9-mm screen. All values on an as-fed basis. Alfalfa = ◇, corn silage = ○. Solid line is the predicted mean particle size and dashed lines are the 90% confidence intervals on new observations.