

SCiO Cup External Validation Review - Spring 2022

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Executive Summary

- Subtle, underrecognized dry matter changes in forage and commodity feeds are costing farmers in feed cost and likely animal performance
 - Practical experience with 1 to 2 unit unrecognized DM changes has been associated with \$0.05 to \$0.10 per hundredweight in margin opportunities
 - This could be equated to \$0.08 per head, for an average dairy farm
- Rock River Laboratory, Inc. conducted an external validation study to evaluate the SCiO Cup performance
 - Alfalfa and corn silage samples evaluated
 - Data set included SCiO cup and commercial laboratory measures for numerous users and locations
 - Over 700 observations
- Following a deviation analysis, 80% of the time the difference between Rock River Laboratory commercial dry matter result and SCiO Cup measure was less than 3.0 units
 - On average RRL and SCiO Cup reported the same DM
- In the simple XY plot analysis, standard error estimates were 1.9 and 2.5 for corn silage and legume silage, respectively
 - Resulting standard error estimates are similar to that observed in prior validation studies
- Following multiple linear regression analysis, there was not a significant effect attributed to NIR Type
 - Model accounted for feed type, location, and feed type x location interaction
 - *Practically, Rock River Laboratory commercial laboratory technique and SCiO cup reported the same dry matter result*
- ***The SCiO Cup accuracy appears suitable for dairy or beef farms or consultants for forage DM updates***

Introduction

Inherent forage and commodity feed dry matter content variation can be attributed to forage or feed type, cutting, field, vendor or processing facility, crop year, changes over time or external weather conditions when feeding these feeds. While the dairy and beef industries recognize forage dry matter content changes over time, the extent and frequency of substantial changes is

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likely not fully understood (Goesser, 2022). More frequent forage analyses are hindered primarily by costs in labor or laboratory analysis. Further, wet and dry feeds commodity feeds also contain more variation than has been commercially understood and warrant routine dry matter assessment. Underrecognized and unaccounted for dry matter changes in fermented forages or commodity feeds can represent \$0.05 to \$0.10 per hundredweight margin and economic opportunity at minimum. Dairy or beef performance gains associated with subtle changes in dry matter likely contribute to additional margin opportunities. On farm or site near-infrared reflectance (NIR) technology and instruments provide a means to routinely assess dry matter on these feeds, and improve the plane of nutrition for dairy and beef farms. The SCiO Cup (Consumer Physics) is an instrument that has been developed for application in ruminant nutrition and agriculture. Both the instrument and forage and feed models have been developed by Consumer Physics. The NIR models have evolved over the several year life span of the SCiO cup, and an external validation for instrument and model performance is warranted. The objective of this evaluation is to determine if the SCiO Cup is capable of mimicking the commercial feed analysis performance for dry matter content.

Methodology and Data Analysis

Over a several month period of time, Rock River Laboratory, Inc. (RRL, Watertown, WI) continuously analyzed commercial feed samples via the SCiO Cup in addition to commercial feed analysis. In brief, a sample was first scanned in the SCiO Cup, and then this sample was immediately transferred to a paper weigh boat for the commercial dry matter analysis. Whole-plant chopped corn silage and alfalfa silage samples were enrolled in this study. Five different RRL locations were enlisted to participate in the study, ensuring that multiple users and multiple SCiO Cups were included. One location (RRL Ohio) was dropped from the evaluation due to a deviation from specified protocol for this project. The final dataset included 568 observations as detailed in Table 1. The resulting data evaluated included: commercial dry matter (RRL DM), SCiO Cup DM (SCiO DM) and the absolute value deviation between RRL DM and SCiO DM (DM Dev.). Raw means by feed type, location and analysis technique are also presented in Table 1.

Table 1: Sample numbers and mean dry matter or deviation results by feed type and location

Feed	Lab	N	Mean (RRL DM)	Mean (SCiO DM)	Mean (DM Dev. - Abs)
Corn silage	Colby	68	38.1	38.0	1.0
Corn silage	New York	36	37.6	37.8	1.3
Corn silage	Watertown	128	38.2	39.1	2.2
Corn silage	West	72	35.3	35.4	1.2
Legume silage	Colby	37	41.9	40.7	2.0
Legume silage	New York	37	40.7	40.8	3.1
Legume silage	Watertown	175	43.6	44.3	2.0

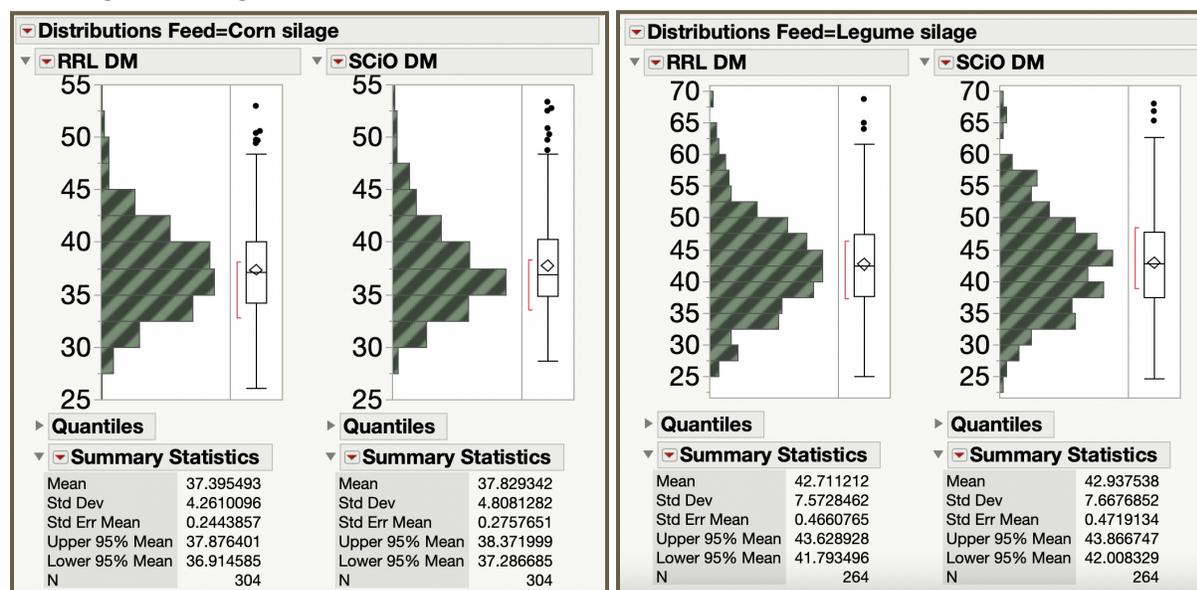
Legume silage	West	15	39.4	38.2	2.1
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The data were analyzed in several ways using JMP Pro v15.2.1 (SAS Institute, Cary, NC). These included a distribution analysis, XY plot and multiple linear regression analysis using a backwards elimination method. For linear regression analysis, fixed effects for feed type, location, NIR type (RRL or SCiO) and two way interactions were evaluated and retained in the model when $P < 0.10$. Significance was declared at $P < 0.05$. The final model retained feed type, location and feed type x location. Of note, NIR type was not retained in the final model.

Discussion

In the distribution analysis for RRL DM and SCiO Cup DM by feed, the 95% confidence intervals overlapped for the different data distributions, suggesting DM results are statistically similar (Figures 1a and 1b) in population mean. The distribution of DM results also appears to be similar for RRL DM and SCiO Cup DM. Practically speaking, the average and distribution for DM results from the SCiO Cup is similar to that reported by RRL.

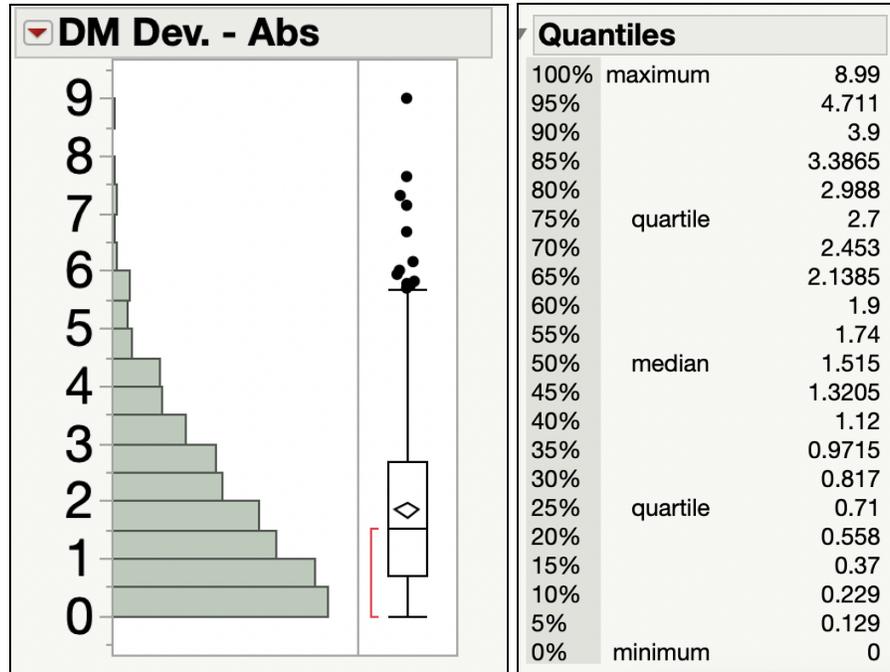
Figure 1a and 1b: Distribution analysis for RRL DM and SCiO Cup DM, for Corn silage and Legume silage.



Another way to evaluate data is to analyze the absolute value of the deviation between the SCiO Cup and RRL for each sample in the project. This observation becomes insightful to understand expected deviation between the on-farm NIR instrument and a commercial laboratory result, often considered the gold standard. Analyzing these deviations via a distribution analysis, and evaluating the quantiles, provides means to understand the percentage of results falling into quantiles. For example, the quantile for here results suggests that 80% of results deviated by less than 3.0 units, with 3.3 units deviation for legume silage and 2.6 units for corn silage, respectively (Figure 2). Further, 50% of the time the results appear to

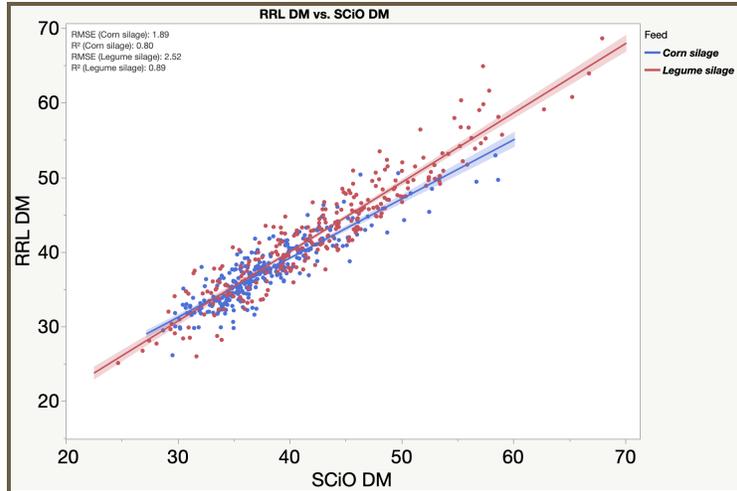
deviate less than 1.5 units. In general, the distribution analyses suggest similar populations for DM measurements and the deviations appear reasonable.

Figure 2: Distribution analysis for the absolute value of the deviation between RRL DM and SCiO DM.



To assess accuracy in addition to precision, linear regression analysis (XY Plot) and multiple linear regression analysis were performed. The root mean square error (RMSE) following simple linear regression analysis suggested errors of 1.9 and 2.5 units for corn silage and legume silage, respectively (Figure 3). The model R^2 values were 0.80 for corn silage and 0.89 for legume silage. The corn silage observed R^2 is likely hindered by limited range to the dataset, with a majority of observations between 30 and 45% dry matter, with a small fraction of observations between 45 and 60% DM (Figure 3). The simple linear regression analysis suggests acceptable agreement between the two techniques.

Figure 3: XY Plot for SCiO DM in relation to RRL DM, by feed type for corn silage and legume silage. The observed RMSE values were 1.9 and 2.5 for corn silage and legume silage, respectively.



The more complex multiple linear regression analysis sought to understand the significant factors in relation to the observed dry matters. Using a backwards elimination method, NIR model type (i.e. RRL vs SCiO) was not retained in the model after accounting for significant variance contributing by other factors. This observation suggests that even after variance components were accounted for with other parameters such as feed or location, there was still no difference in DM results attributable to RRL or SCiO and these approaches yield statistically similar results. Location ($P < 0.001$), feed type ($P < 0.001$), and a trend for location x feed interaction ($P < 0.07$) were all retained in the model.

Summary and Conclusion

This project represents an extensive SCiO Cup evaluation, including multiple instruments across multiple locations and cups operated by different users. The resulting data were analyzed via several different paths, to explore accuracy and interactions that may be evident. The results suggest acceptable agreement between the SCiO Cup and Rock River Laboratory, Inc. commercial dry matter technique. The standard error following simple linear regression analysis is approximately 2.2 units when averaged for corn and legume silages. Based upon these observations, the SCiO Cup accuracy appears suitable for dairy or beef farms or consultants for forage DM updates.

References

Goeser, J.P. 2022. Uncovering hidden or under recognized feed cost and margin opportunities on your dairy farm. Proc. California Animal Nutrition Conference. Sacramento, CA.