

Graphically Communicating Hay Test Results—A Tale of Two Nutrients

Abstract

Our purpose with this article is to share the benefit of using a scatter plot created from hay test results for total digestible nutrients and protein to teach livestock producers four important forage and feeding concepts. The concepts are that a producer's hay is likely not of average quality, nutrients are not independent, hay quality varies on individual farms and across farms, and supplemental feed needs vary according to animal nutrient requirements and fall within one of four categories. Overall, our "tale of two nutrients" tool has served us well as an effective visual aid that can be adapted to meet local needs.

Keywords: [hay test](#), [results interpretation](#), [scatter plot](#)

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Introduction

Total digestible nutrients (energy available in the form of digestible protein, fat, and carbohydrates) and protein are required in the diet of livestock for maintenance and production (National Academies of Sciences, Engineering, and Medicine, 2016). An analysis of more than 8,000 Arkansas hay samples submitted for routine nutrient analysis revealed that 71% of hays were deficient in total digestible nutrients and 41% of hays were deficient in protein for mature beef cows in early lactation (Davis, Gadberry, & Troxel, 2002). Hay feeding in Arkansas may begin as early as mid-November and continue into mid-April of the following year. In response to concerns about ranch profitability and sustainability associated with hay quality and long-term hay feeding, we created the Winter Feed Meeting program. The first meeting occurred in 2008. The program is offered at a county or multicounty level. Participants submit hay samples for routine nutrient analysis, and a production meeting is scheduled to discuss results. Over time, we have found a scatter plot of total digestible nutrients and crude protein—which we view as telling a tale of two nutrients—to be a useful tool for educating both participants and nonparticipants. In this article, we illustrate how key forage management and livestock nutrition concepts can be extracted from a single scatter plot base layer.

Data Compilation and Analysis

The data we use herein for illustration represent a subset of samples from the fall 2017 Winter Feed Meeting program. The data set contained 201 samples from 58 farms and 10 counties. Statistical summaries and plots were generated using R (www.r-project.org) through the RStudio (www.rstudio.com) graphical user interface and R packages psych and plotrix. The foundation for the teaching concepts we describe is a base scatter plot where the horizontal axis is hay sample total digestible nutrients and the vertical axis is hay sample crude protein.

Scatter Plot as Teaching Tool

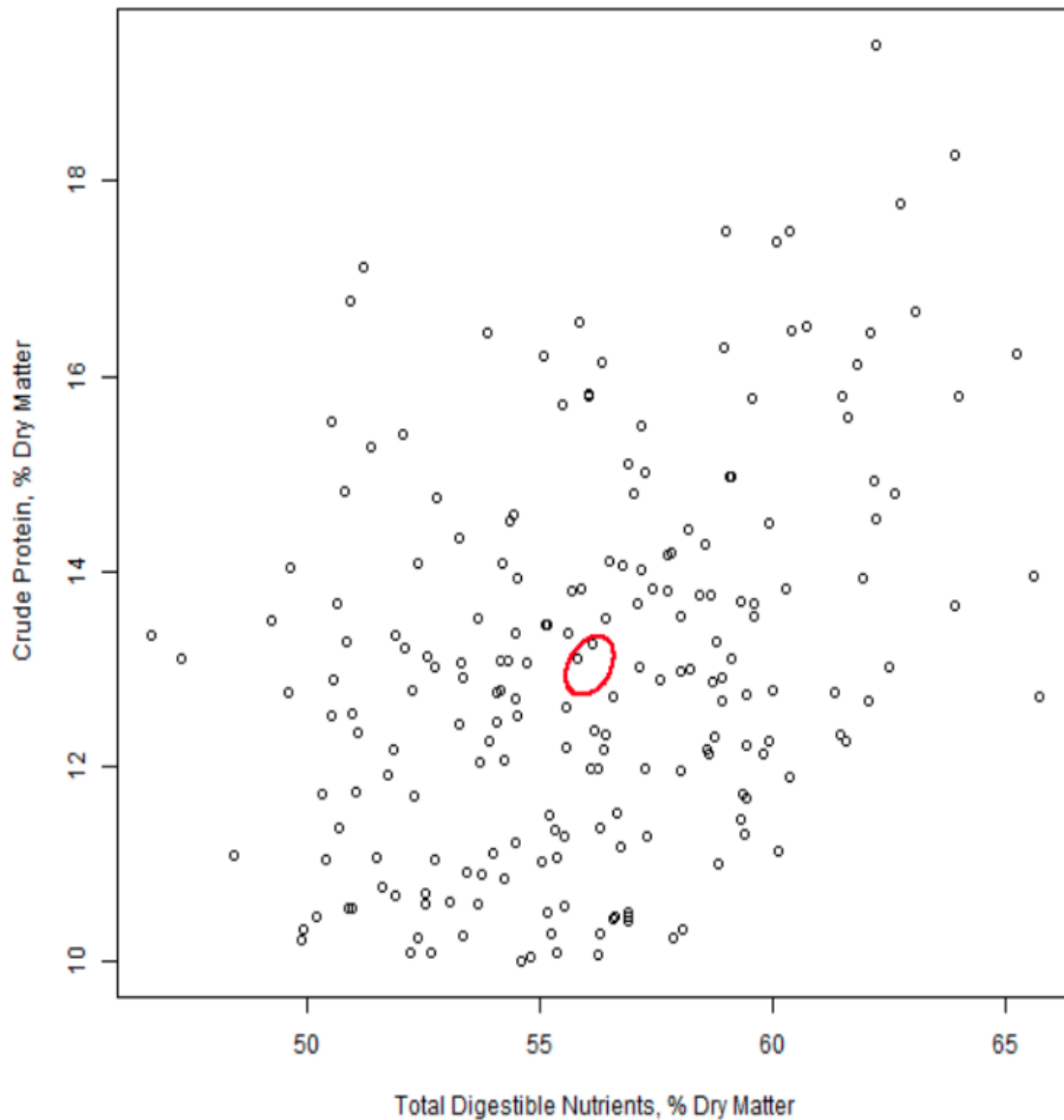
We use the tale of two nutrients to teach four important forage and feeding concepts. For each concept, we make a simple modification to the base scatter plot.

Concept 1. Your Hay Is Probably Not Average

From our experience, very few producers test hay, and it is common for producers to characterize quality as either "average" or "fertilized/unfertilized." Whether or not quality is known, our experience has also taught us that producers have little understanding of total digestible nutrients and generally associate quality with crude protein. To illustrate the concept that hay on a given farm is likely not representative of average, an ellipse layer (Figure 1) is added to the base scatter plot. The ellipse is based on the 95% confidence interval for the standard error mean of both total digestible nutrients and crude protein, and the direction corresponds to their correlation. Among the 201 samples collected, only two fall within our confidence interval about these means.

Figure 1.

Scatter Plot of Producer Hay Test Results with an Ellipse Characterizing the Mean Confidence Interval and Correlation

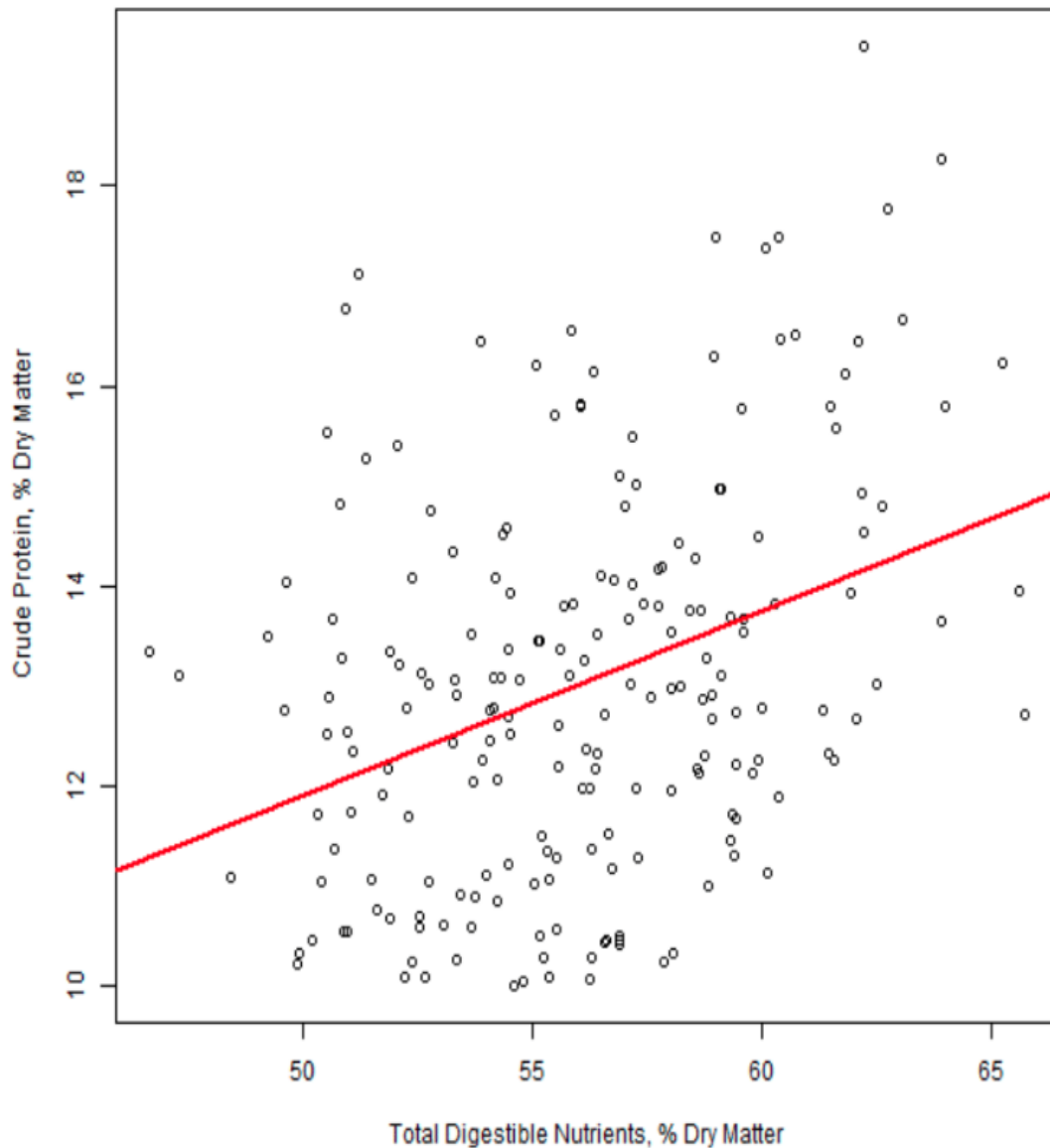


Concept 2. Forage Total Digestible Nutrients and Protein Are Not Independent

To illustrate the relationship of total digestible nutrients and protein, a line generated from the intercept and slope coefficients of a linear model is layered over the base plot (Figure 2). This modification aids in teaching the concept that management practices can improve both total digestible nutrients and protein at the same time. For example, fertilization improves yield, allowing for earlier harvest to achieve the same tonnage but with greater quality because the forage is less mature at earlier harvest. Deviations from this line highlight that there are instances in which hays may be low in total digestible nutrients but moderately high in protein and vice versa. Therefore, one is not a good predictor of the other.

Figure 2.

Scatter Plot of Producer Hay Test Results with a Layer Illustrating the Relationship Between Total Digestible Nutrients and Protein

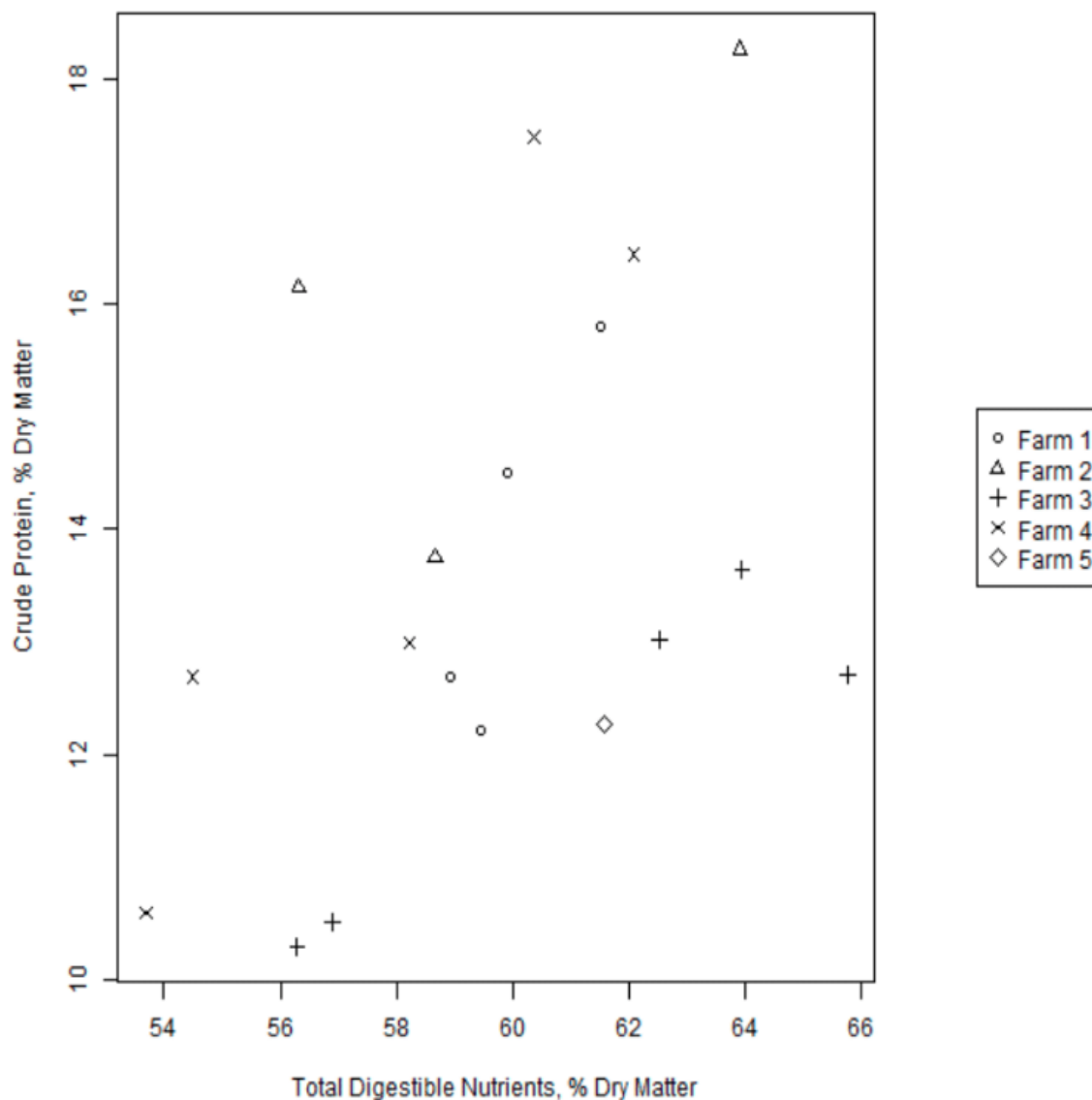


Concept 3. Hay Quality Varies Among and Within Farms

Thus far, all data points have been represented by an open circle. To teach the concept of variation among and within farms, data points are changed to represent a shape associated with each farm. To illustrate, a subset of samples from a single county is shown in Figure 3.

Figure 3.

Scatter Plot of Producer Hay Test Results within a County



Concept 4. Supplemental Feed Needs Fall Within One of Four Categories

In most cases, our participants were either feeding third-stage-pregnancy or lactating cows. To illustrate how supplementation needs differ relative to maternal stage and hay quality, two figures are generated by adding horizontal and vertical lines to the base plot (Figures 4 and 5). The lines are associated with the dietary nutrient density requirement of the cow. The lines create a grid that shows producers whether or not hays are meeting total digestible nutrient and/or protein needs. The meanings of the four sections of the grid are as follows:

- In the top right section are hays that are sufficient in total digestible nutrients and protein and require no addition of these nutrients to the diet.
- In the top left section are hays that require supplemental feeds high in total digestible nutrient content but not necessarily high in protein content.
- In the bottom left section are hays that require supplemental feeds high in both total digestible nutrient and

protein content.

- In the bottom right section are hays that require no supplement specifically targeting total digestible nutrients but require supplements high in protein content. In our particular situation, illustrating this section is critical. Clientele often choose supplemental feeds that are high protein. These supplements are expensive, usually fed in small quantities, and often inappropriate for hays that fit within the other three sections.

Figure 4.

Scatter Plot of Producer Hay Test Results with Lines Representing the Dietary Nutrient Density Requirement of a Mature Beef Cow During Late Gestation

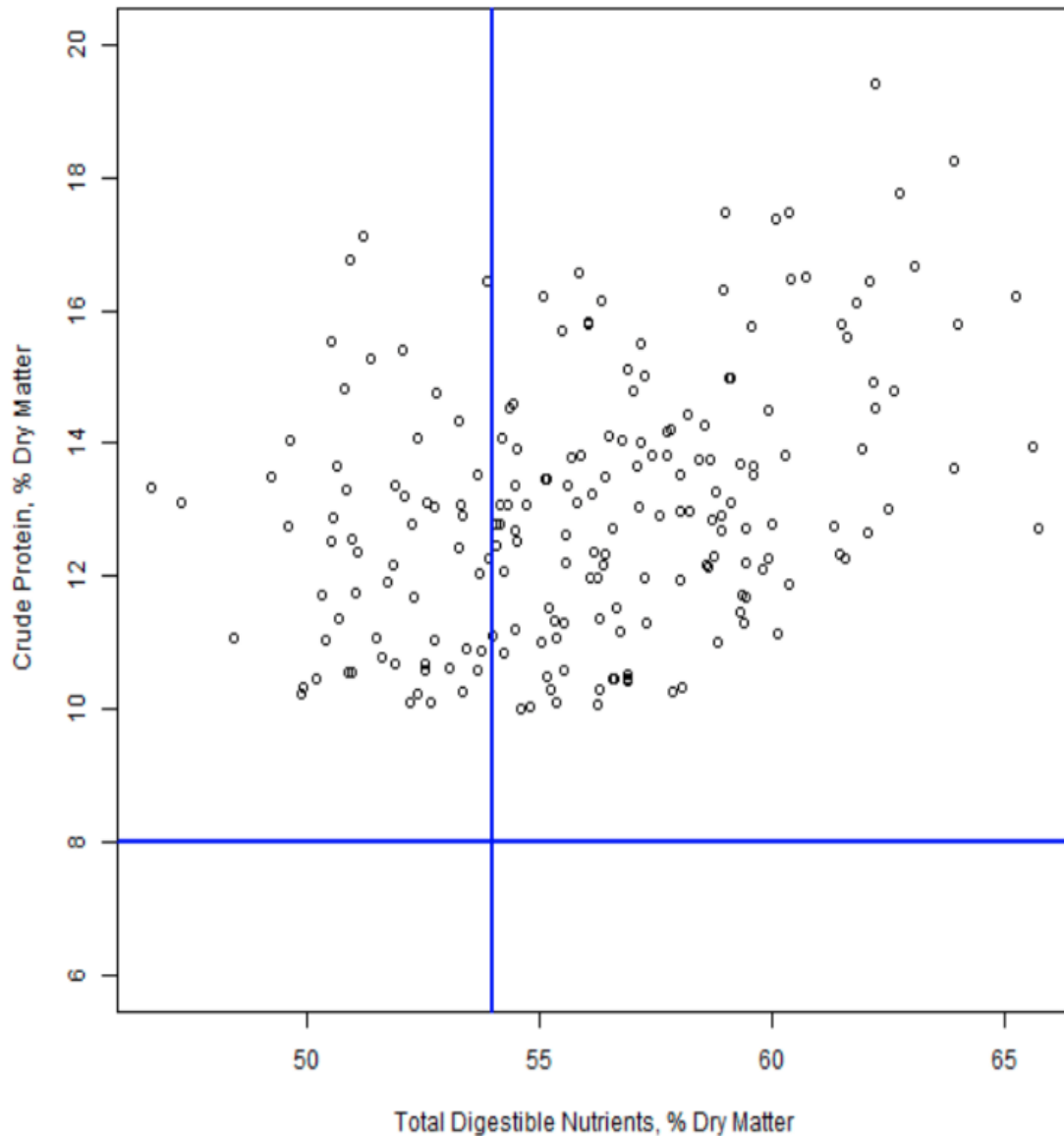
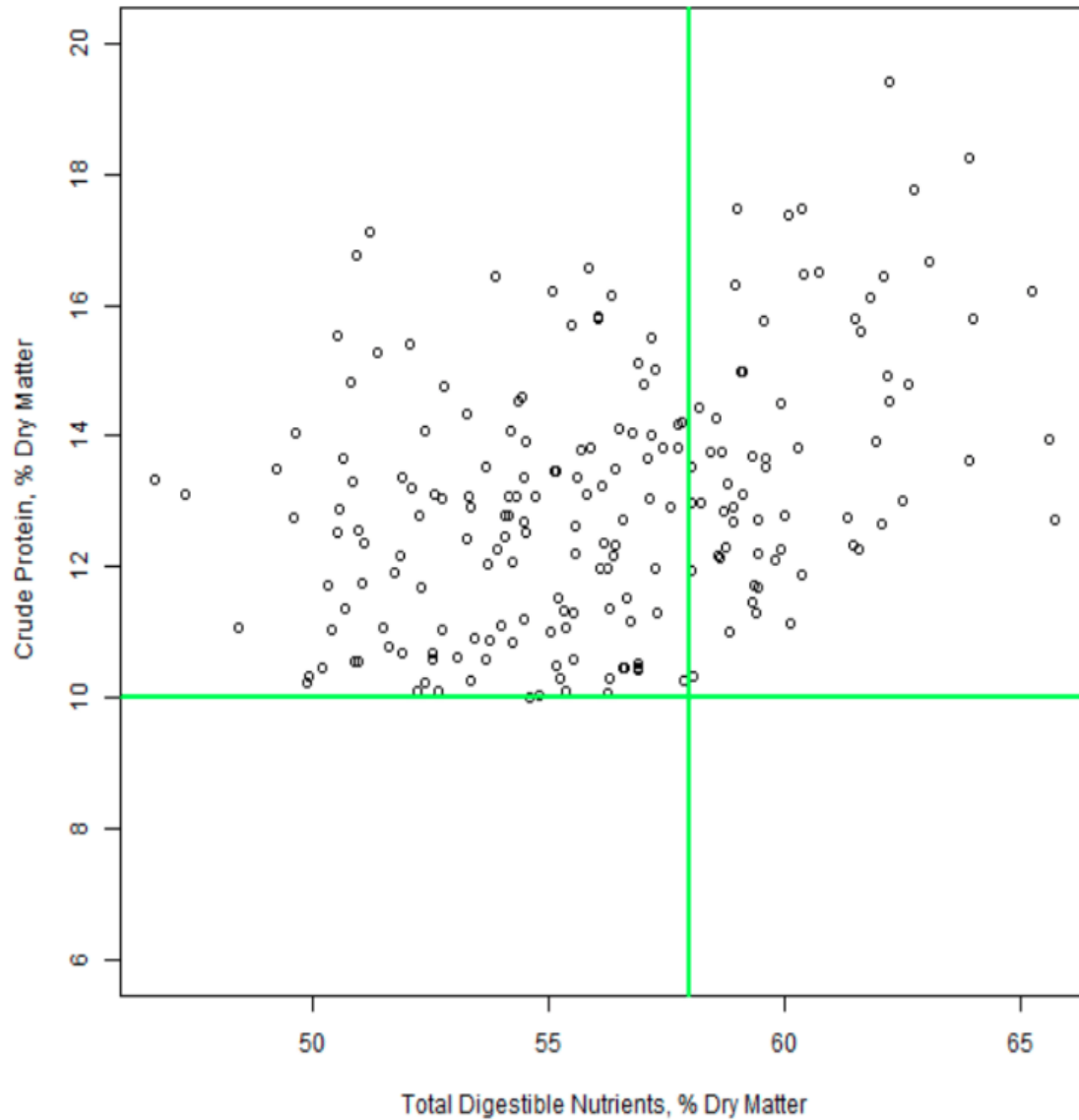


Figure 5.

Scatter Plot of Producer Hay Test Results with Lines Representing the Dietary Nutrient Density Requirement of a Mature Beef Cow During Early Lactation



Conclusions

Graphs can be an effective means for transferring knowledge (Powers, 1966). A tale of two nutrients has been a valuable tool for teaching basic concepts of forage quality, nutrient requirements, and the importance of forage testing in making correct supplemental feeding decisions. As a result of our sharing results in this manner, some clients have requested copies of farm-level graphs. Extension agents can adapt the Winter Feed Meeting program concept to educate local producers about the benefits of forage testing, including identifying farm-specific nutrient deficiencies, choosing the right supplement, and improving hay quality.

References

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