ISC 2025
XX INTERNATIONAL SILAGE CONFERENCE

Thoughts on Silage Quality and Analysis

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CVAS

Observations regarding forage analysis

- In the U.S., volume of forage (silage) analysis has been driven by needs of the dairy industry.
- High throughput of forage materials at the dairy requires fast turnaround of analysis allowing for recognition of change.
- Cornell Net Carbohydrate Model (CNCPS v6.5.5) defines much of the requested nutrient set.
- Breadth of analysis requested leaves NIR as the analytical tool of choice.

Observations regarding forage analysis

- Expectation is for the forage laboratory to provide same day analysis of most forage and feed ingredient materials.
- Samples need to be received, logged, dried, ground analyzed, reviewed, and reported, generally within an 8-hour workday.

Laboratory Consolidation

- Consolidation has occurred in the forage testing industry in part as the need to engage expensive technologies such as Laboratory Information Management Systems (LIMS), high-end laboratory equipment, specialized systems such as in vitro fiber analysis, and specialized labor.
- Examples of high-end laboratory equipment include:
  - ICP - minerals
  - XRF - minerals
  - LIBS - minerals
  - GC – fermentation acids, fatty acids, and others
  - LC – mycotoxins, fermentation acids, amino acids
  - LC MS/MS - mycotoxins
  - IC - carbohydrates
  - NIR – organic compounds

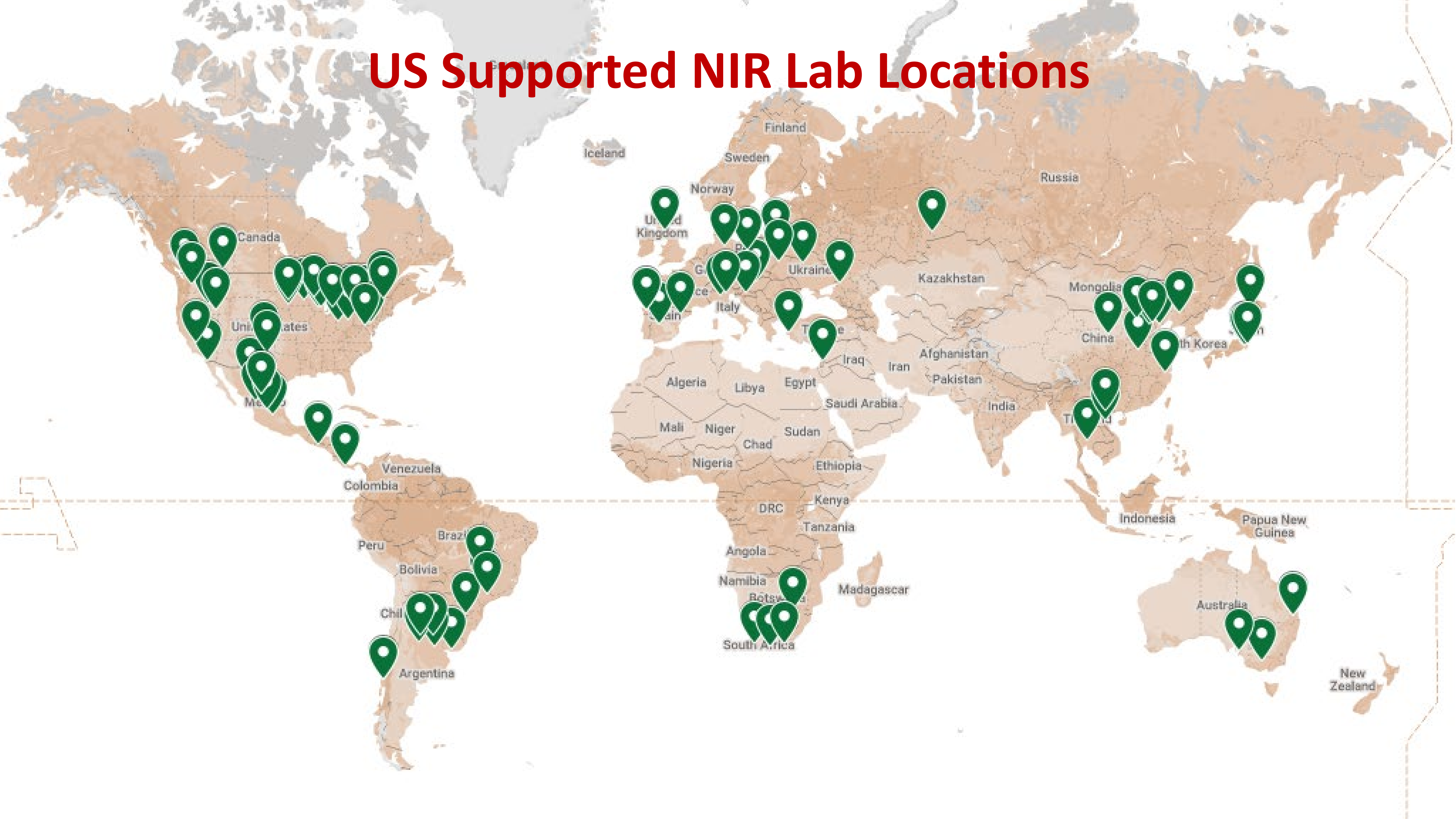
Key US Forage Laboratories

- There are 4 primary labs serving the needs of the ruminant marketplace in the U. S. -
  - Cumberland Valley Analytical Services (CVAS)
  - Dairyland Laboratories
  - Rock River Laboratory
  - Dairy One Forage Laboratory

NIR as a tool to promulgate silage analysis

- To develop and maintain NIR calibrations it is necessary to either maintain many of these analytical systems or to lease equations from a larger lab entity that can maintain these diverse and expensive analytical systems.

US Supported NIR Lab Locations



NIR as a tool to promulgate silage analysis

- High investment in traditional chemistry methods requires significant sample volume to support this investment.
- As an example – All 4 key U.S. labs utilize LC-MS/MS for analysis of mycotoxins. Clients perceive the analysis of more mycotoxins to be better, in part leading to the use of LC-MS/MS.

Mycotoxin Testing by Feed Type

CVAS, July 1, 2024 -June 30, 2025

Feed Category	Key Ingredients	% of Samples
Byproducts/Ingredients	Corn Distillers Grains	20.4
Forages	Corn Silage	26.1
Grains	Corn Grain	29.6
Miscellaneous Feed types		8.40
Protein Feeds	48% Soybean Meal	2.90
Total Mixed Rations		12.6

Mycotoxins Tested in Corn Silage

July 2024 – July 2025

Toxin	% Positive	Ave.	St. Dev		Toxin	% Positive	Ave.	St. Dev
Aflatoxin B1	1.5	13.9 ppb	28.0		HT2	56.5	50.1 ppb	71.1
Aflatoxin B2	0.2	5.50 ppb			Ochratoxin A	0		
Aflatoxin G1	0.3	57.9 ppb	78.9		3 Acetyl DON ppm	0		
Aflatoxin G2	0.3	57.9 ppb	78.9		15 Acetyl DON ppm	42.3	0.39	0.43
Deoxynivalenol	87.7	2.36 ppm	2.58		Citrinin, ppb	0		
Zearalenone	51.3	308 ppb	491		Fusarenon X, ppm	0		
Fumonisin B1	67.1	2.26 ppm	3.35		Nivalenol, ppm	0		
Fumonisin B2	49.3	0.87 ppm	1.22		Neosolaniol ppb	0		
Fumonisin B3	25.1	0.45 ppm	0.42		Diacetoxyscirpenol, ppb	4.0	331	
T2	1.9	7.68 ppb	2.24					

NIR as a tool to promulgate silage analysis

Key points for bringing NIR into a prediction network:

- Instruments supported in forage networking are limited. Typically, they must be certain models of Foss NIR or Blue Sun. This is a concern for long-term support of a forage network.
- Forage types to be predicted must be represented in the NIR equation database. For example, semi-tropical forages cannot be accurately predicted from a temperate forage database.
- Instruments to be brought into a network need to be standardized by forage type. This involves the transfer of samples and scanning on both the client and master instruments.

NIR Predictive Potential

Equation Evaluation

- A significant consideration of predictive potential of an equation is the relationship between the standard error of the calibration (SEC) and the SD of the population.
- In our lab, we consider an SD/SEC >3 to be an acceptable prediction potential.
- A ratio of SD/SEC <2 provides little predictive potential.

Corn Silage Nutrient Predictive Potential: SD/SEC

>2 <3	N03, C18:0, C18:1, Ca, Mg, S, P
>3 <4	NDFD30, TAAN%DM, TFA, CP, Starch 7HR, Ash
>4 <6	CP, Fat, Acetic, Sugar, Lactic, Lignin, uNDF240
>6 <9	WSC, NH3, Starch, NDFom, Cl
>9	ADF, NDF

NIR as a tool to promulgate silage analysis

Equation Validation

- “Reporting forage nutritive value using near-infrared reflectance spectroscopy”. Miguel S. Castillo et al. Crop Science. 2025;65:e70063.

  “… the accuracy of NIR predictions cannot be assumed because a NIR solution produces a number.”

  “Validation by comparing laboratory-measured versus NIR-predicted values, using samples outside the calibration dataset, remains essential to identify potential anomalies and assess the accuracy of NIR-predicted values.”

NIR as a tool to promulgate silage analysis

Equation validation – standard error of the prediction (SEP)

- *If you rely on NIR values for forage characterization or ration modeling, do you know what the "validated" standard error of prediction (SEP) is for a given nutrient?*
- *The standard error of calibration (SEC) is based on samples used in the calibration. The standard error of prediction (SEP) is based on verification samples that are not part of the calibration.*

NIR as a tool to promulgate silage analysis

Equation validation

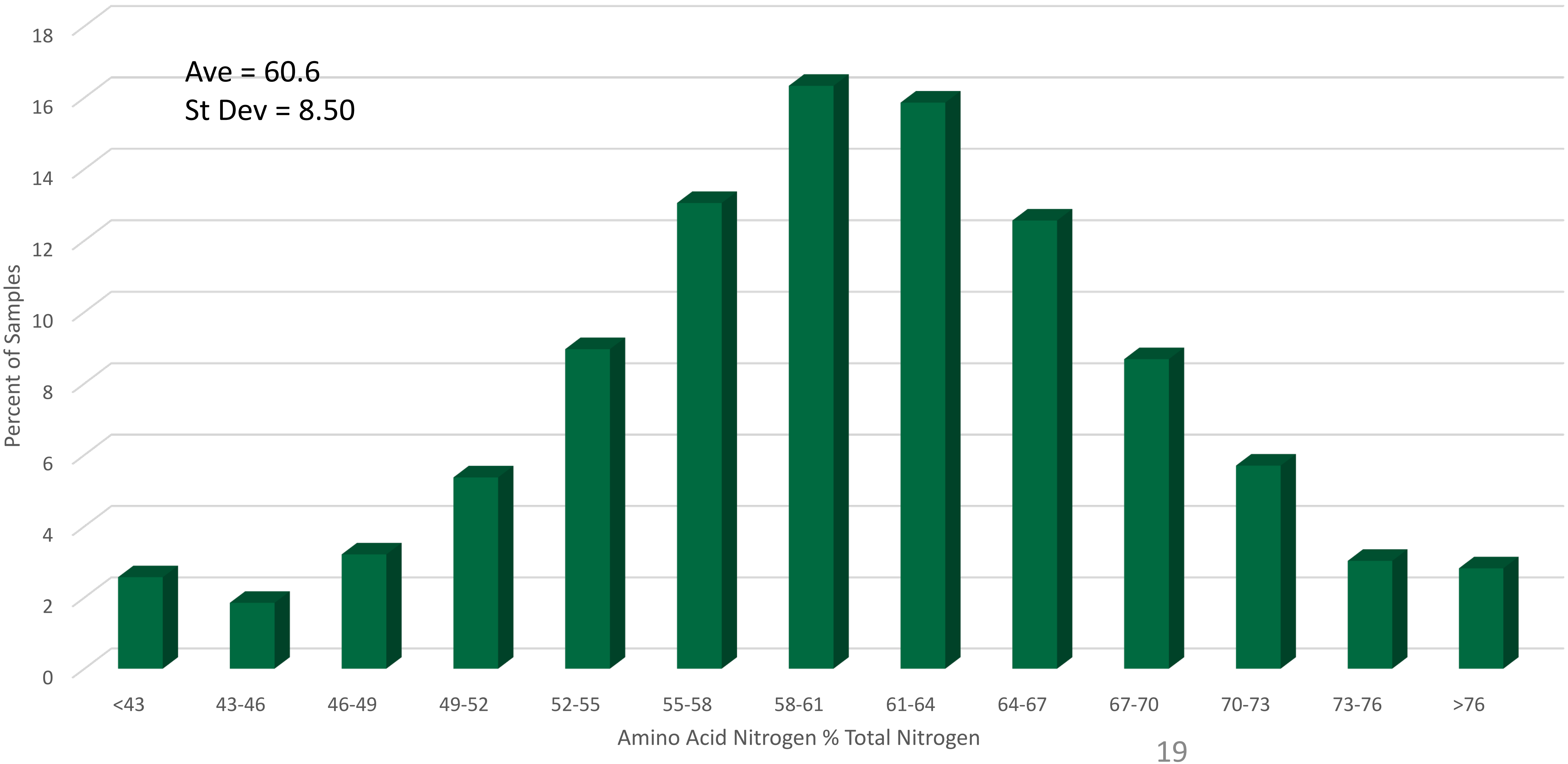
- **SEP** is probably the most descriptive statistic for evaluating a model's predictive accuracy.
- The magnitude of the **SEP** will depend in part on how well the independent validation samples are represented by the samples that were used in the calibration, the quality of the chemistry reference data, and the resolution of the spectrometer.
- Can the NIR lab support their service by providing the **SEC** and **SEP** statistics of predicted nutrients?

NIR Scanning – Coarse heterogeneous vs fine ground increases SEP and impacts predictive potential of an equation

Hay crop silage amino acid equation statistics

Constituent	Mean	RSQ	SECV	SD/SECV
Cysteine	0.12	0.94	0.01	3.28
Methionine	0.21	0.98	0.01	5.08
Aspartic Acid	1.14	0.94	0.19	3.24
Threonine	0.49	0.96	0.05	3.95
Serine	0.46	0.92	0.07	2.86
Glutamic Acid	1.08	0.89	0.15	2.59
Proline	0.82	0.87	0.14	2.22
Glycine	0.63	0.97	0.05	4.25
Alanine	0.95	0.86	0.17	2.08
Valine	0.77	0.98	0.06	4.85
Isoleucine	0.55	0.98	0.04	5.05
Leucine	0.94	0.97	0.08	4.70
Tyrosine	0.29	0.95	0.04	3.46
Phenylalanine	0.86	0.91	0.11	2.77
Histidine	0.21	0.91	0.04	2.74
Lysine	0.58	0.92	0.10	2.86
Arginine	0.31	0.96	0.04	4.29
Total AAN, %DM	**1.42**	**0.98**	**0.09**	**5.87**
Total AA, %DM	10.9	0.98	0.75	5.53

Distribution of amino acid nitrogen as a percentage of total nitrogen in hay crop silage



NIR as a tool to promulgate silage analysis

Qualitative assessment of silage fermentation by NIR

- pH
- Fermentation acids
- Ammonia
- **Amino acid N % Total N**

Thank you!

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