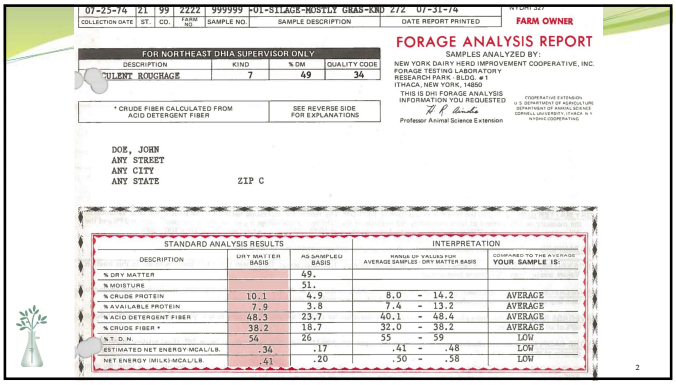
Tri-State Dairy Nutrition Conference

2018 Pre-conference Symposium

Trends, Opportunities, and Future Technologies

Ralph Ward

Cumberland Valley Analytical Services



07-25-74 | 21 | 99 | 2222 | 999999 | 01-SILAGE-MOSTLY GRAS-KND 272 | 07-31-74
COLLECTION DATE | ST. | CO. | FARM NO. | SAMPLE NO. | SAMPLE DESCRIPTION | DATE REPORT PRINTED

FARM OWNER

FORAGE ANALYSIS REPORT

SAMPLES ANALYZED BY:
NEW YORK DAIRY HERD IMPROVEMENT COOPERATIVE, INC.
FORAGE TESTING LABORATORY
RESEARCH PARK - BLDG. #1
ITHACA, NEW YORK, 14850

THIS IS DHI FORAGE ANALYSIS INFORMATION YOU REQUESTED

Professor Animal Science Extension

COOPERATIVE EXTENSION
U.S. DEPARTMENT OF AGRICULTURE
DEPARTMENT OF ANIMAL SCIENCE
CORNELL UNIVERSITY, ITHACA N.Y.
NYDHIC COOPERATING

FOR NORTHEAST DHIA SUPERVISOR ONLY

DESCRIPTION	KIND	% DM	QUALITY CODE
ULENT ROUGHAGE	7	49	34

* CRUDE FIBER CALCULATED FROM ACID DETERGENT FIBER

SEE REVERSE SIDE FOR EXPLANATIONS

DOE, JOHN
ANY STREET
ANY CITY
ANY STATE ZIP C

STANDARD ANALYSIS RESULTS			INTERPRETATION	
DESCRIPTION	DRY MATTER BASIS	AS SAMPLED BASIS	RANGE OF VALUES FOR AVERAGE SAMPLES - DRY MATTER BASIS	COMPARED TO THE AVERAGE YOUR SAMPLE IS:
% DRY MATTER		49.		
% MOISTURE		51.		
% CRUDE PROTEIN	10.1	4.9	8.0 - 14.2	AVERAGE
% AVAILABLE PROTEIN	7.9	3.8	7.4 - 13.2	AVERAGE
% ACID DETERGENT FIBER	48.3	23.7	40.1 - 48.4	AVERAGE
% CRUDE FIBER *	38.2	18.7	32.0 - 38.2	AVERAGE
% T. D. N.	54	26	55 - 59	LOW
ESTIMATED NET ENERGY-MCAL/LB.	.36	.17	.41 - .48	LOW
NET ENERGY (MILK)-MCAL/LB.	.41	.20	.50 - .58	LOW

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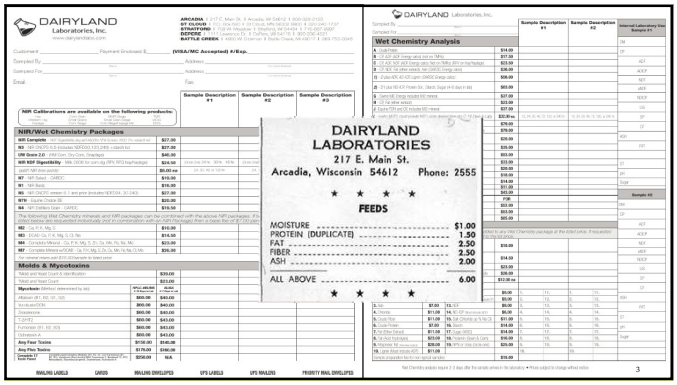

DAIRYLAND Laboratories, Inc.
ARCADIA
ST CLOUD
STRATFORD
DEFORE
BATTLE GREEN

DAIRYLAND LABORATORIES
217 E. Main St.
Arcadia, Wisconsin 54612 Phone: 2555

★ ★ ★ ★

FEEDS

MOISTURE	$1.00
PROTEIN (DUPLICATE)	1.50
FAT	2.50
FIBER	2.50
ASH	2.00
ALL ABOVE	6.00

★ ★ ★ ★

NIR Calibrations are available on the following products:

NIR/Wet Chemistry Packages

Molds & Mycotoxins

Wet Chemistry Analysis

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Trend

- As we have seen marked changes in feed analysis in the past 30 years, the next 10 years will bring significant additional characterization opportunities to the field of ruminant nutrition.

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Amino Acid Analysis

- Amino acids have been run for many years
- Generally a multi-step preparation procedure then a sample is run through a sophisticated chromatography unit
- These units can run $50,000 to $400,000 depending on the technology
- Labor intensive
- Costly

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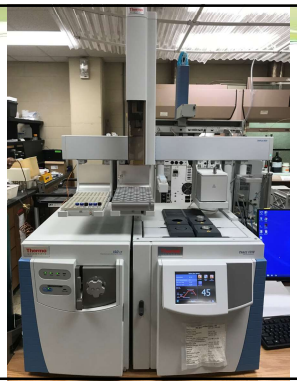

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Amino Acid Analysis

- Amino acids have been routinely been part of poultry and swine diet feed characterizations
- Smaller number of feeds, relative homogeneity in feeds
- NIR has been successfully used to characterize these feeds

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Amino Acid Analysis

- Amino acid analysis has not been used significantly in ruminant feed evaluation.
- Large number of potential feedstuffs to characterize
- Significant variation in feedstuff quality and character
- Harvest, storage, and fermentation conditions may lead to significant differences in amino acids delivered to the cow

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Amino Acid Analysis

- We have been able to create a NIR calibration for total amino acids in corn silage.
- Our objective is to first work on establishing a set of NIR calibrations for total amino acids in all key forage classes.
- At the least, this will allow us to understand better how much of the nitrogen in a forage material is amino acid nitrogen.
- Once this is accomplished, we can evaluate calibrations for key amino acids of importance in ruminant nutrition.

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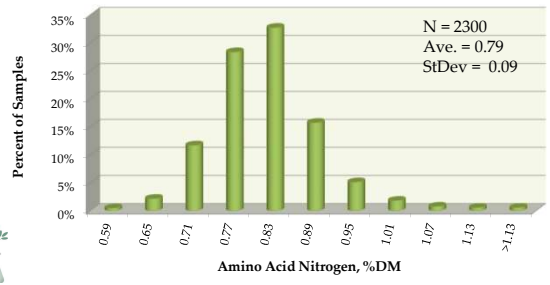
Distribution of Amino Acid Nitrogen as % DM in Corn Silage



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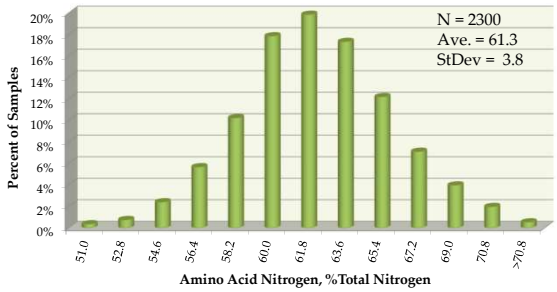
Distribution of Amino Acid Nitrogen as % Total Nitrogen in Corn Silage



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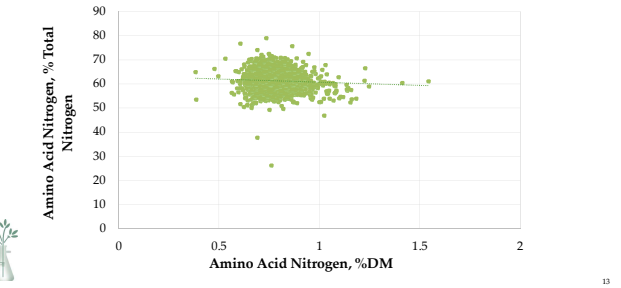

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Amino Acid Analysis

- Initial evaluation of broad range of hay crop silages:
  - Protein: 9.7% to 22.5%
  - Amino acid nitrogen as % total nitrogen: 46% to 80%
    - Average: 61.5% SD: 19.1

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Opportunity

- Over the next 3 to 5 years there will be significant engagement of amino acid characterization of ruminant feedstuffs. NIR will probably become a key tool to bring this about.

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Quality Characterization - Amines

- **Biogenic amines** are basic nitrogenous compounds formed mainly by decarboxylation of amino acids or amination and transamination of aldehydes and ketones. Biogenic amines are synthesized by microbial, vegetable, and animal metabolisms. In food and beverages they are formed by the enzymes of raw material or are generated by microbial decarboxylation of amino acids.

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Amine Content of Selected Legume Silages

%DM (detection limit 5 ppm)

	23765059	23605013	23719146	23763127
Cadaverine	.19	.36	.15	.14
Histamine	.06	.16	.04	.04
Phenethylamine	.05	.01	.03	.02
Putrescine	.10	.21	.07	.08
Spermine	<.01	<.01	<.01	.01
Tryptamine	<.01	.06	.02	.01
Tyramine	.13	.24	.16	.08
Total Amine	.71	1.04	.57	.37
Dry Matter	29.7%	30.1%	33.4%	40.0%

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Quality Characterization - Amines

- Need to understand prevalence in feed materials
- Need to understand correlation to indexes of fermentation
- Need a better understanding of what point these products are toxic to or impacting negatively the metabolism of the cow
- Potential to use NIR as a screening tool to identify feeds potentially high in amines

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Quality Characterization - Mycotoxins

- In the early 1980's mycotoxins were a concept that was just starting to be discussed in dairy nutrition.
- Today mycotoxins have become a key component of nutritional management and are recognized globally as an animal and human health threat.
- Significant improvements have occurred in recent years in the array and quality of technologies available to evaluate mycotoxins.
- At CVAS, we originally used thin layer chromatography, ELISA, outsourced HPLC, internally run HPLC, moving toward LC MS/MS.

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Quality Characterization - Mycotoxins

- LC MS/MS provides the opportunity for internal verification of toxins, a broader scope of mycotoxin identification with less sample preparation, very low detection levels, and rapid analysis.

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Example of Toxin Detection Limits – LC MS/MS

	Units	Detection Limit
Deoxynivalenol	ppm	0.1 ppm
15-Acetyl Deoxynivalenol 15	ppm	0.1 ppm
3-Acetyl Deoxynivalenol 3	ppm	0.1 ppm
Aflatoxin B1	ppb	0.1 ppb
Aflatoxin B2	ppb	0.1 ppb
Aflatoxin G1	ppb	0.1 ppb
Aflatoxin G2	ppb	0.1 ppb

	Units	Detection Limit
Fumonisin B1	ppm	0.1 ppm
Fumonisin B2	ppm	0.1 ppm
Fumonisin B3	ppm	0.1 ppm
HT-2	ppb	5 ppb
Ochratoxin A	ppt	50 ppt
T-2	ppb	5 ppb
Zearalenone	ppb	12.5 ppb

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Quality Characterization - Mycotoxins

Future trend:

- Mycotoxins will be run less expensively
- Larger panels
- Significantly lower detection limits
- Fewer labs providing service but with large investment in equipment and personnel

Strach Characterization - CSPS

- Corn silage processing score has been used significantly over the last number of years
- Labor intensive lab evaluation
- Costly for information provided
- Some analytical limitations

Ro-tap shaker showing 4.75mm screen and corn retained on the sieve

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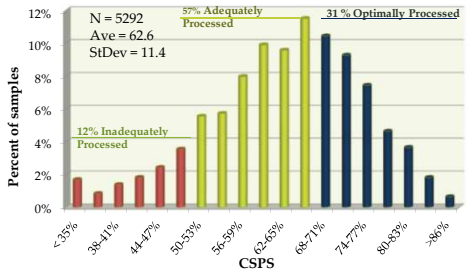
Distribution of Corn Silage Processing Scores



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U.S. Industry Makes Advances in Corn Silage Processing Past 10 YRS (CVAS Data, 2006 - 2016)

Crop Year	Number	Average	Percent Optimum	Percent Poor
2006	97	52.8	8.2	43.3
2007	272	52.3	9.2	37.9
2008	250	54.6	5.2	34.8
2009	244	51.1	6.1	48.0
2010	373	51.4	5.9	43.4
2011	726	55.5	12.3	33.1
2012	871	60.8	14.8	19.9
2013	2658	64.6	26.2	22.1
2014	4634	62.2	25.8	10.4
2015	3231	61.1	24.2	17.5
2016	3598	63.5	30.8	11.5

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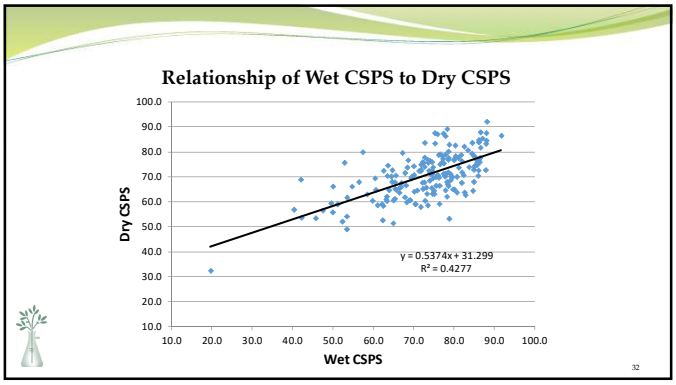

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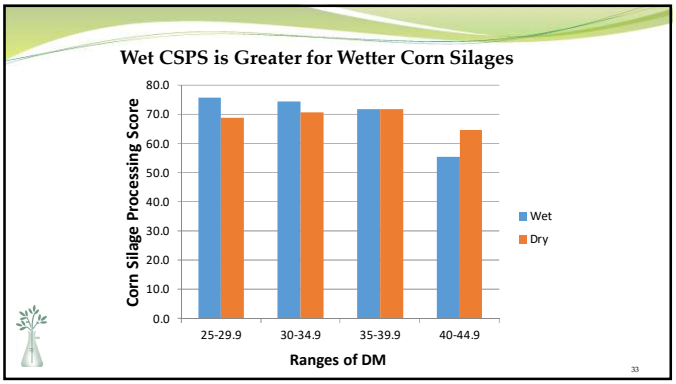

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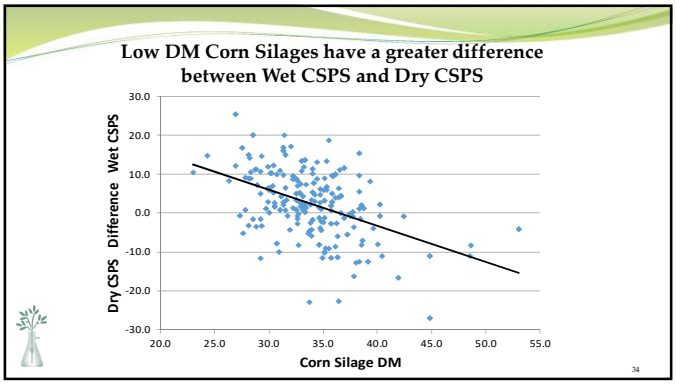

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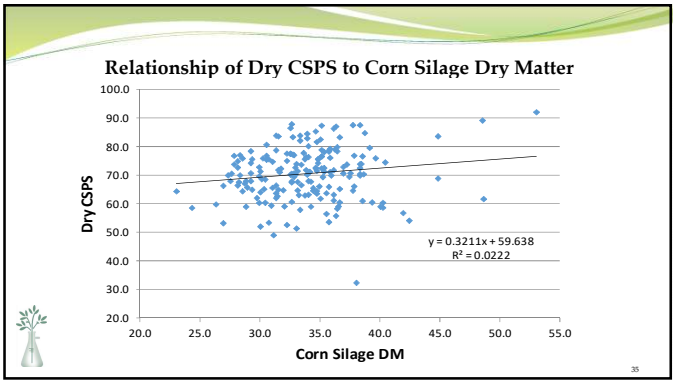

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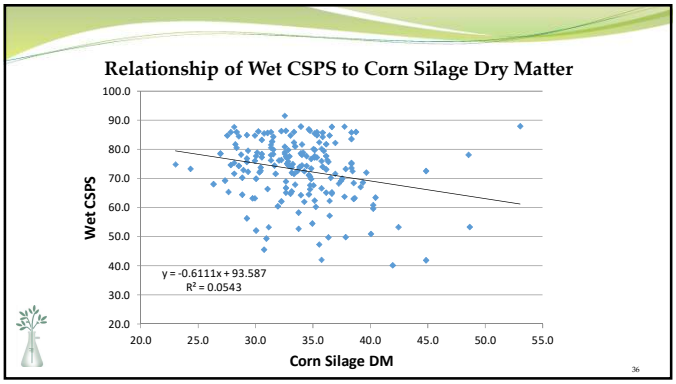

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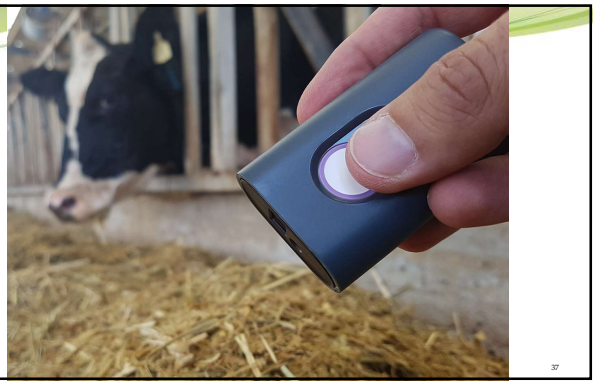

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Initial/Annual Costs for Various On-Farm NIRS

Instrument	Contact	Form Factor	List Price
HarvestLab™	John Deere	Portable[1]	$25,000
AuroraNIR™	RCI Engineering	Hand-held	$19,500
X-NIR™	Dinamica Generale	Hand-held[1]	$14,000
poliSPEC	ITPhotonics	Hand-held[1]	$18,500
Moisture Tracker™	Digi-Star	Hand-held[1]	$7,350
StellarCASE-NIR	StellarNet	Portable	$20,500

[1]Also offered with connectivity and mounting hardware for on-harvester use. Additional costs apply.

Matthew Digman, Forage Focus, March, 2018 39

Chemical constituents predicted by on-farm NIRS systems

Instrument	Dry Matter	NDF/ADF	Starch	Sugar	Crude Protein	Crude Fat
HarvestLab™	++	++	+-	+	++	--
AuroraNIR™	++	++	++	--	++	++
X-NIR™	++	++	+	+-	++	++
poliSPEC	++	++	++	+	++	++
Moisture Tracker™	++	--	--	--	--	--

++Available for all crop species, +available for most crop species, +-available for some crop species, --not available

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Hand-held NIR

- Questions to ask:
  - Is accuracy acceptable? Does the vendor provide the equation and model validation statistics?
  - Who supports the technology / verification / updates?
  - Do I want to own administration and technology obsolescence?
  - If the value is immediacy of information, can this information be effectively engaged in management systems to bring value?

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Hand-held NIR

- Evaluation is of raw material which is generally very heterogeneous
- Evaluation of moisture is a correlation between surface moisture and total moisture
- NIR precision is diminished by high moisture

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Additional Opportunities

- Starch degradability characterization
  - Modeling digestibility using other characteristics including particle size
  - Gas production
  - Pure enzyme systems in place of rumen fluid
  - Evaluation of actual fed samples instead of ground materials

Additional Opportunities

- Managing aggregate farm data for process control

Change creates opportunity!

Thank you!

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