Hay Analysis Reports

& How to Understand Results

Green River Rancher's Workshop, Pinedale

11/29/2023

Dagan Montgomery

University of Wyoming | Extension Sublette County

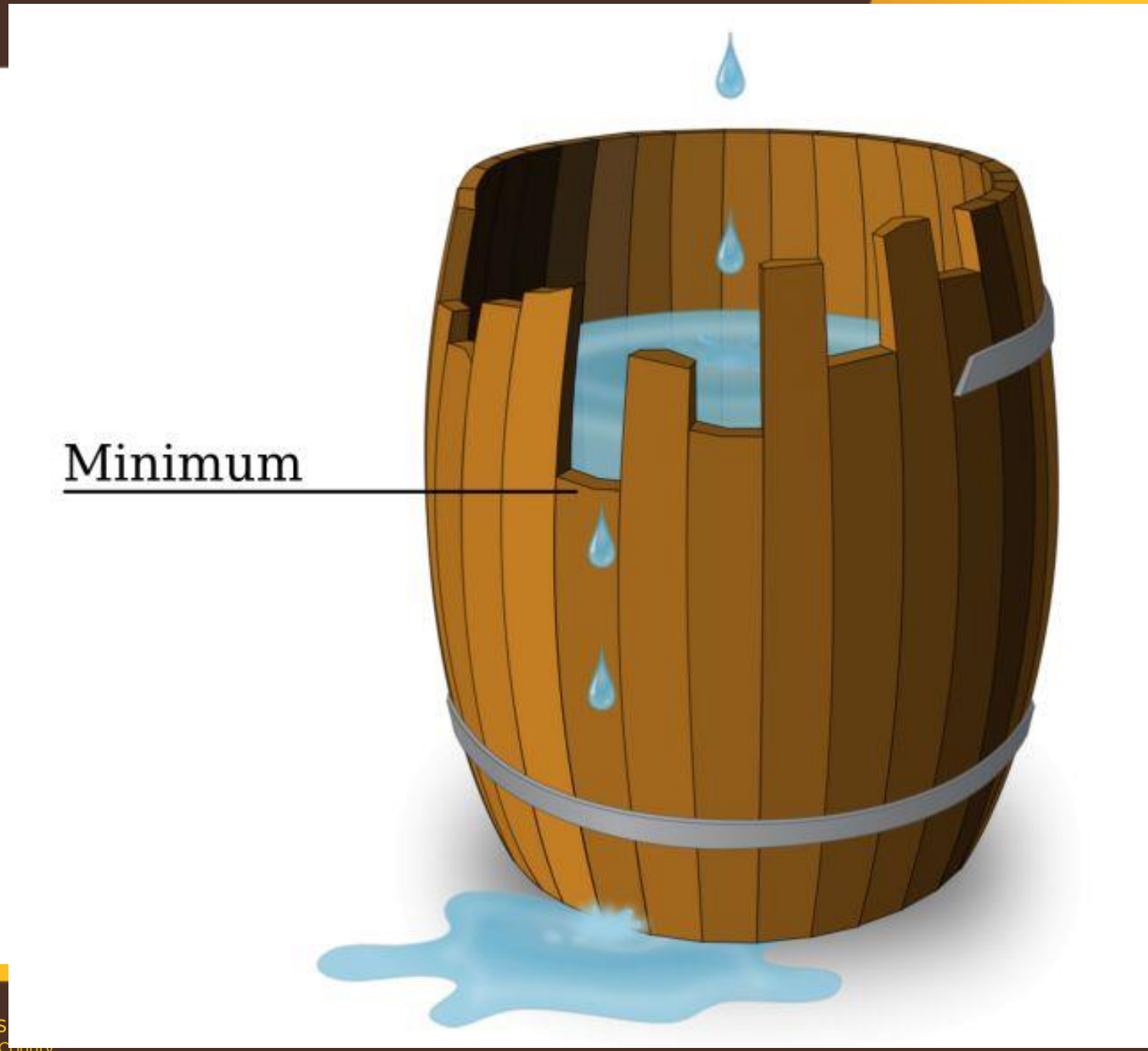
Introduction:
Why should I test my hay at all?

- Allows you to see the actual nutrient content and quality of hay vs. the assumed quality

  >Maturity, soil, fertilizer regimen, rainfall, cultivar all effect nutrient quality

Why should I test my hay at all?

- Hay is the predominant feed source for the harshest months of the year
  - Failing to meet animal requirements jeopardizes performance
    - >Sacrificed weight gain
    - >Struggle to recover in Spring
    - >Low breed back


Minimum

Why should I test my hay at all?

Marketing Hay

>Providing an analysis helps pricing (especially in dairy)

Why should I test my hay at all?

Nutritional Triage

> Provide highest quality to highest demand

(developing heifers, heavily pregnant cows, growing calves, nursing cows, etc.)

Why should I test my hay at all?

- Record keeping
  - >Think of it as taking inventory, no different from counting bales
- Relatively cheap and simple
  - > ~$20 a sample

Before the information can be used...

It must be understood

Methods of Analysis: Wet Chemistry Vs. NIRS

Wet Chemistry:

- Collective term for multiple lab analysis
- Considered the most accurate and precise

Methods of Analysis: Wet Chemistry Vs. NIRS

Wet Chemistry:

- Used for quality control, feed labeling, etc.
- Considerably more expensive and time consuming

Methods of Analysis: Wet Chemistry Vs. NIRS

NIRS:

- "Near Infrared Spectroscopy"
- Measures near infrared reflectance of compounds without destroying sample
- Accuracy depends on calibration using results from wet chemistry

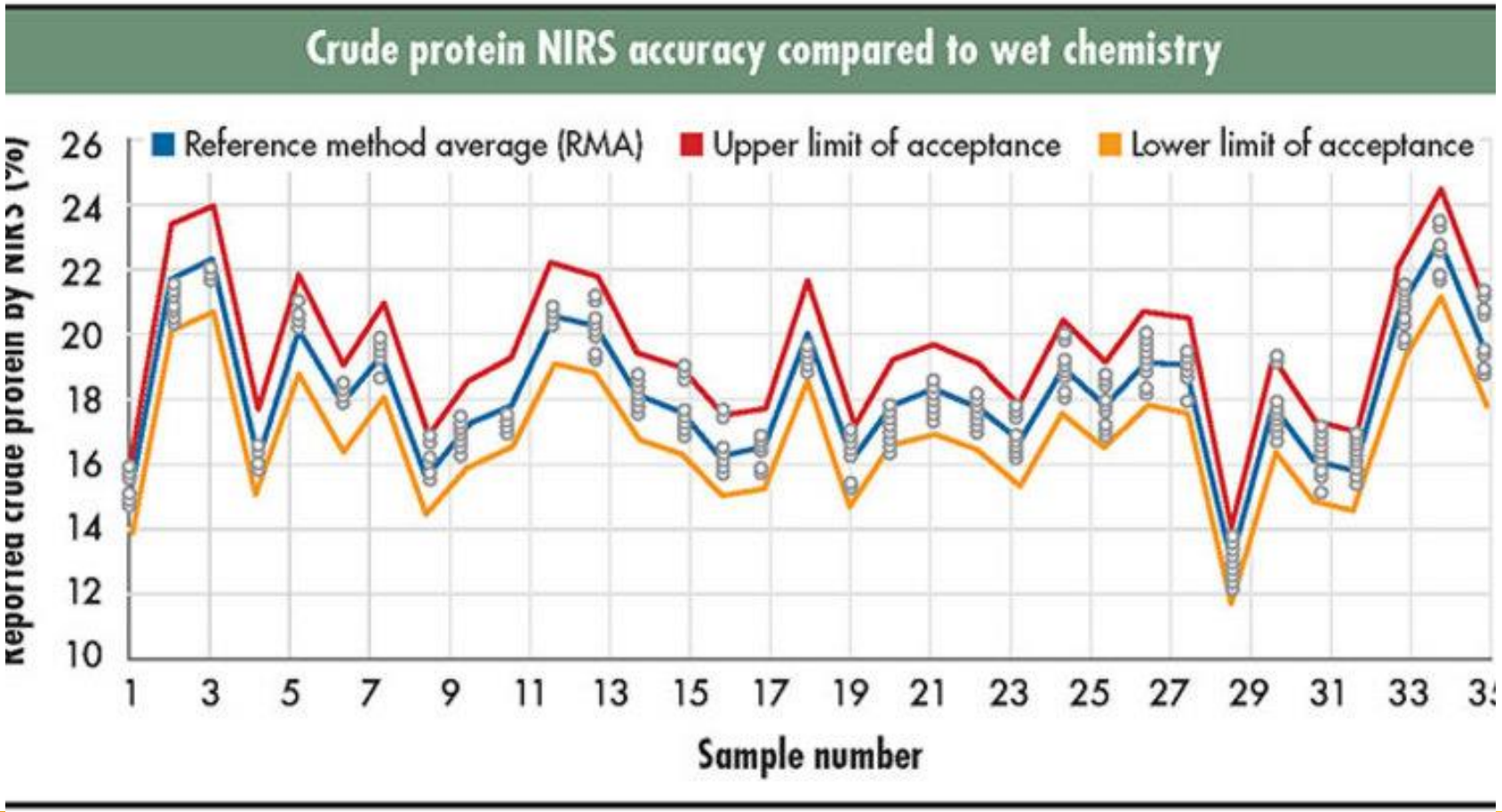
Methods of Analysis: Wet Chemistry Vs. NIRS

NIRS:

- Low cost and rapid
- Considered sufficient for forage analysis for beef operations

*Must identify forage type

Methods of Analysis: Wet Chemistry Vs. NIRS



NIRSConsortium
Forage and Feed

NATIONAL FORAGE TESTING ASSOCIATION
NFTA
Excellence in Forage Testing

[redacted]

Invoice No. : [redacted]
Date Received :
Date Reported :

Lab Number :

[redacted]

Description : GRASS HAY

	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43
*Phosphorus, % P	0.10	0.12
*Potassium, % K	1.20	1.40
*Magnesium, % Mg	0.14	0.16
*Zinc, ppm Zn	22.0	25.6
*Iron, ppm Fe	256	298
*Manganese, ppm Mn	146	171
*Copper, ppm Cu	4.6	5.3
*Sulfur, % S	0.13	0.15
*Sodium, % Na	0.01	0.01
*Molybdenum, ppm Mo	0.94	1.09
Ash, %	2.10	2.45
OTHER ANALYSIS		
Fat, %	2.2	2.5
Starch, %	2.9	3.2
Lignin, %	4.10	4.65
Non Fiber Carbohydrates, %	25.6	29.1
Ethanol-Soluble Carbohydrates, %	9.8	11.1
Water-Soluble Carbohydrates, %	12.5	14.2

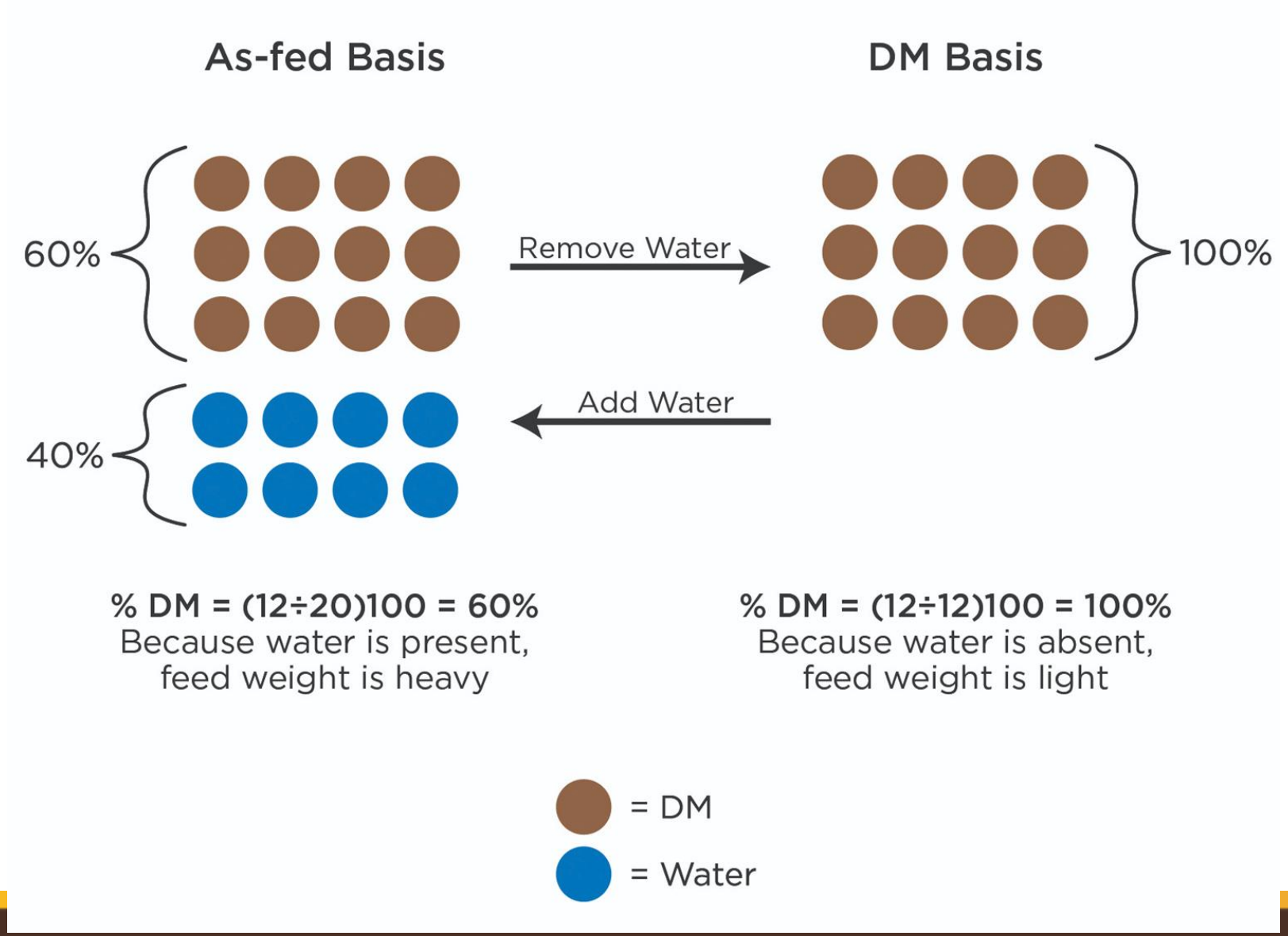
Moisture and Dry Matter (DM)

- First values on report, compares before and after all water is removed
- Expressed as %
- Other values reported as both **Dry Matter** or **DM basis**, and **As-Fed** or **As-Received**

Moisture and Dry Matter (DM)

- Compare values using Dry Matter
  - Water content can vary significantly
  - Minimizes dilution effect

VS.


As-fed Basis
DM Basis
60%
Remove Water
100%
40%
Add Water
% DM = (12÷20)100 = 60%
Because water is present,
feed weight is heavy
% DM = (12÷12)100 = 100%
Because water is absent,
feed weight is light
= DM
= Water

Account No. : [redacted]

NIR Analysis Report

[redacted]

Invoice No. : [redacted]
Date Received : 10/05/2023
Date Reported : 10/09/2023

Lab Number : 13126

Results For : [redacted]
Sample ID :
Description : GRASS HAY

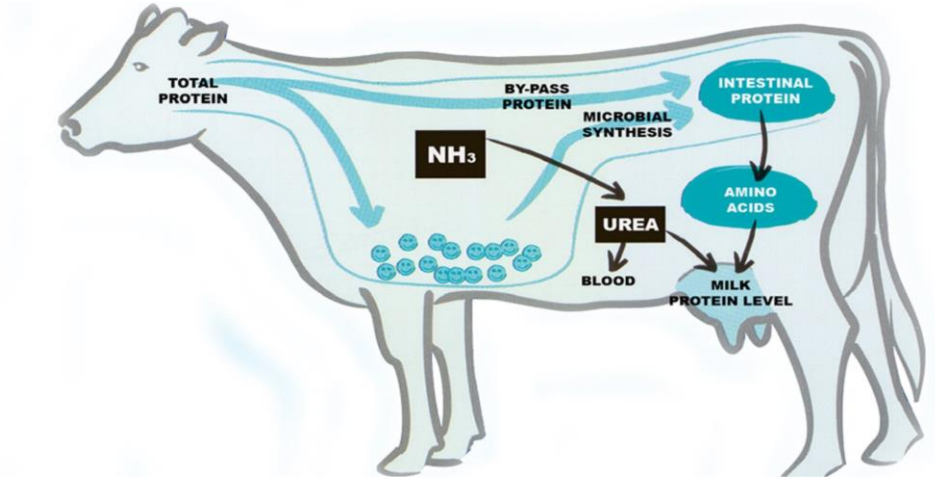
	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43
*Phosphorus, % P	0.10	0.12
*Potassium, % K	1.20	1.40
*Magnesium, % Mg	0.14	0.16
*Zinc, ppm Zn	22.0	25.6
*Iron, ppm Fe	256	298
*Manganese, ppm Mn	146	171
*Copper, ppm Cu	4.6	5.3
*Sulfur, % S	0.13	0.15
*Sodium, % Na	0.01	0.01
*Molybdenum, ppm Mo	0.94	1.09
Ash, %	2.10	2.45
OTHER ANALYSIS		

Ideal Moisture

Harvested Forage Type	Ideal Dry Matter (DM)
Hay	85% DM
Baleage	40 - 60-% DM
Silage	30 - 40% DM

Crude Protein (CP)

- Based on total Nitrogen (N) within the sample
- Critical for production
- Required for maintenance, lactation, growth and reproduction



Crude Protein (CP)

- % of Dry Matter
- Major indicator of the need for supplement
- Caution: high nitrate from soil or fertilizer can lead to artificially high CP

Account No. : [redacted]

NIR Analysis Report

[redacted]

[redacted]

Date Received : 10/05/2023
Date Reported : 10/09/2023

Lab Number : 13126

Results For Sample ID [redacted]
Description : GRASS HAY

	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43

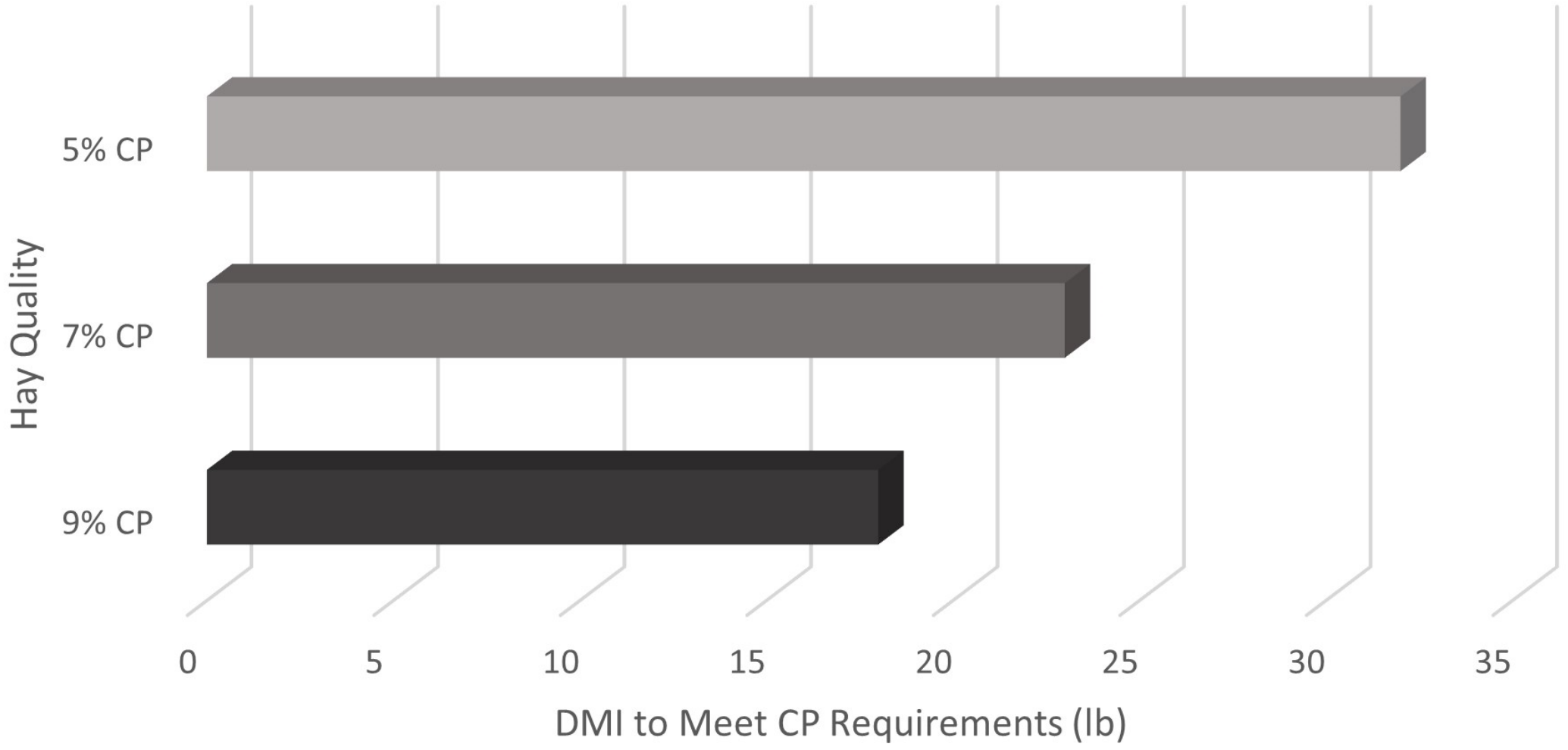
UNIVERSITY OF WYOMING

Crude Protein Requirements for mature cows

Stage of Production	Daily CP Intake (% DM)
Dry, pregnant cow	7% CP
First 60 days of lactation	11% CP
Rest of lactation	9% CP

*Derived form *Nutrient requirements of Beef Cattle* (2016)

Chart 1. 1300-lb Cow DMI of Different Quality Hay to Meet Daily Requirement of 1.6 lb of CP



Nutrient Requirements for Replacement Heifers, based on ADG & a 1,200 lb. expected mature weight, at BCS 5

Stage of Production	Avg. Daily Gain (lbs.)	Dry Matter Intake (lbs./day)	CP (%DM)
2nd Trimester Pregnancy	1.0	16	8.7
	1.5	16	9.8
	2.0	17	10.7
3rd Trimester Pregnancy	1.0	18	8.5
	1.5	19	9.4
	2.0	19	10.3
1st 90 days after Calving	0.0	21	9.7
	0.15	23	11.3
	1.0	24	12.8

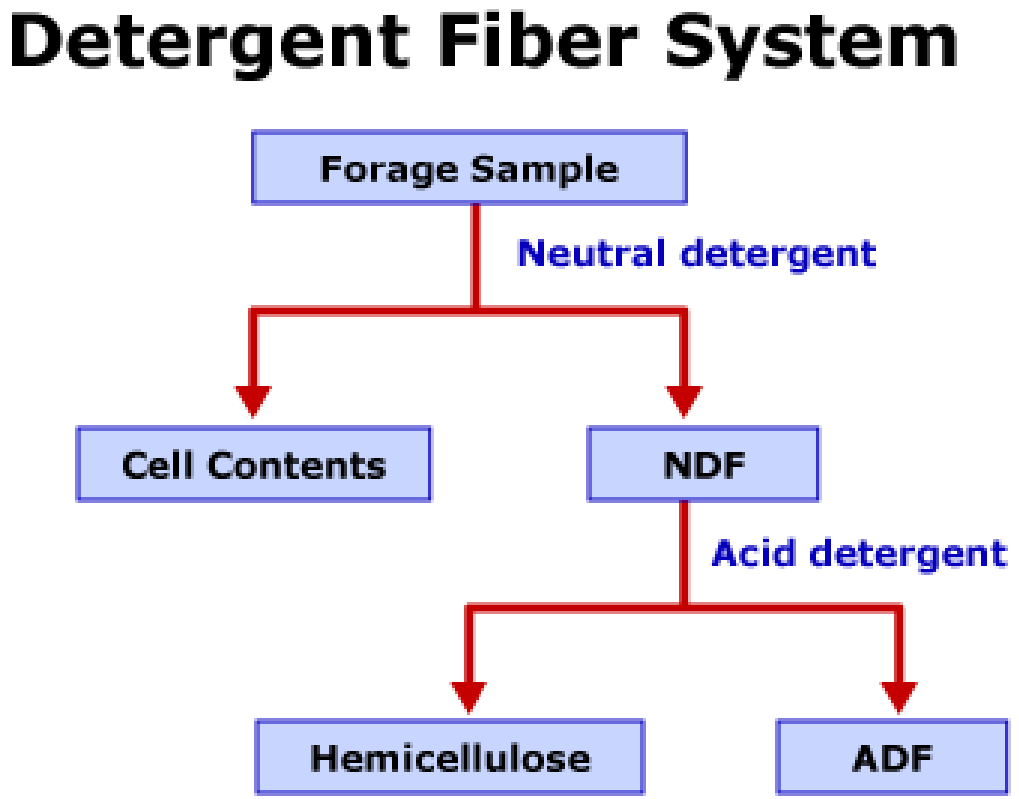
*Derived form *Nutrient requirements of Beef Cattle* (2000)

Fiber

- **Neutral Detergent Fiber (NDF)** and **Acid Detergent Fiber (ADF)**

- % of Dry Matter
- Structural component of the plant

Fiber
ADF & NDF



Account No. : [redacted]

NIR Analysis Report

[redacted]

[redacted]

Date Received : 10/05/2023
Date Reported : 10/09/2023

Lab Number : 13126

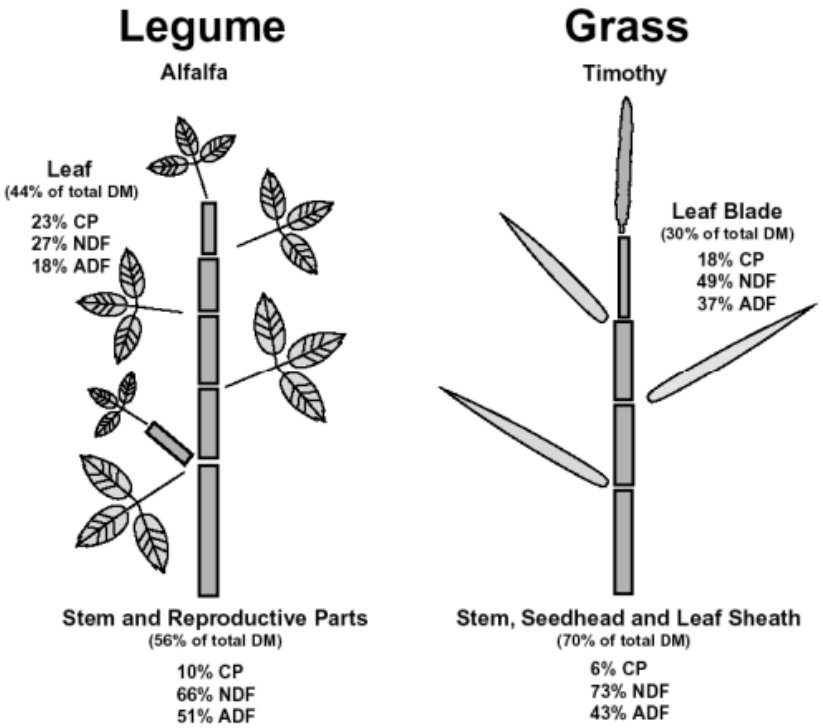
Results For Sample ID [redacted]
Description : GRASS HAY

	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43

UNIVERSITY OF WYOMING

Fiber

- **Both ADF and NDF increase with plant maturity**
- Typically, lower in legumes



Fiber- NDF

- Forage intake ↓ as NDF ↑

- Range ~40 to 65%

  NDF>60% noticeably decreases feed intake

Fiber- NDF

- NDF (%) ÷ 120 = dry matter intake (% of Bodyweight)

Ex: If NDF = 50%, 50/120=2.4

Animal will consume 2.4% of bodyweight in dry matter

Fiber - ADF

- Digestibility of forage ↓ as ADF ↑
- **ADF >40%** = lower quality

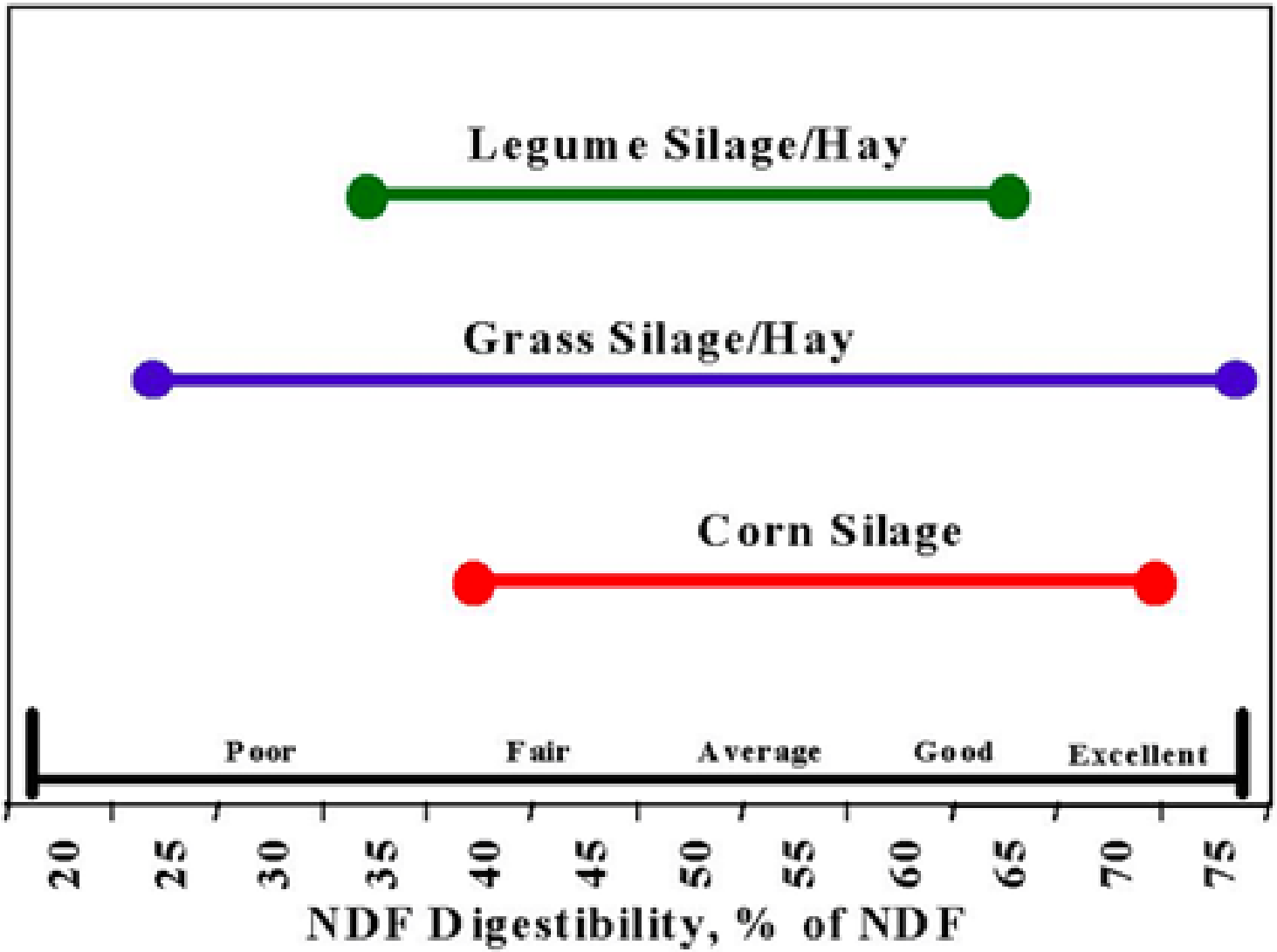
Fiber	Range (% DM)	Ideal
NDF	40 - 65%	< 60%
ADF	30 - 45%	< 40%

Other Fiber Values

Neutral Detergent Fiber Digestibility (NDFD): % of total NDF that is digested

In Vitro Dry Matter Digestibility (IVDMD): % of total dry matter digested after laboratory treatment with rumen fluid

Figure 1. NDF Digestibility of forage species.



Energy-Total Digestible Nutrients (TDN)

- % of Dry Matter
- Calculated value, differs by forage type
- *must specify forage*

Energy-Total Digestible Nutrients (TDN)

- Measure of overall energy value of feed (Carbohydrates, protein, fats)
- Less precise, but is more common and easier

Account No. : [redacted]

NIR Analysis Report

[redacted]

[redacted]

Date Received : 10/05/2023
Date Reported : 10/09/2023

Lab Number : 13126

Results For Sample ID [redacted]
Description : GRASS HAY

	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43

TDN & Quality

Grass Hay	Total Digestible Nutrients (TDN) % DM
High Quality	> 58%
Medium Quality	52% - 58%
Low Quality	< 52%

Nutrient Requirements for a 1,200 lb. mature beef cow

Stage of Production	TDN (%DM)
2nd Trimester of Pregnancy	50%
3rd Trimester of Pregnancy	54%
1st 90 days of lactation after calving (20 lbs./day milk)	58 – 61%

*Derived form *Nutrient requirements of Beef Cattle* (2000)

Energy- Net Energy

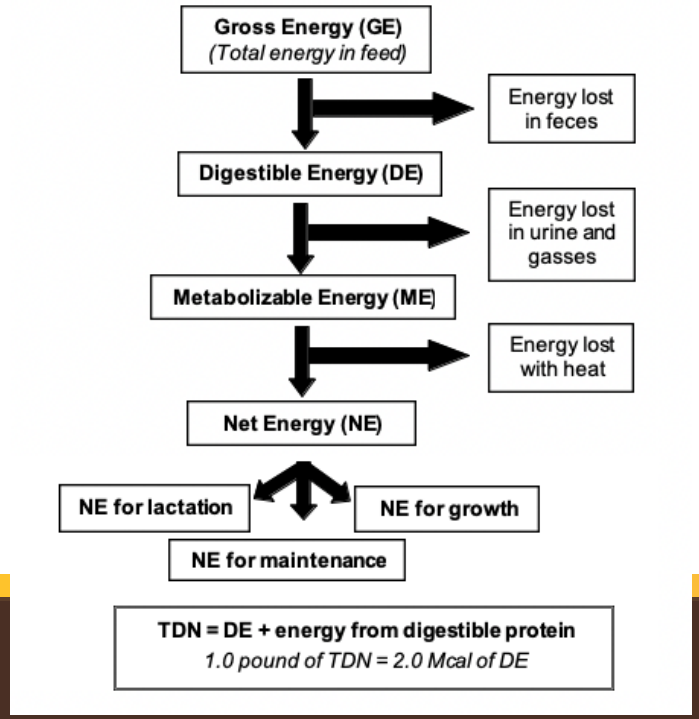
- Reported as **megacalories (Mcal)/lb**

Net Energy for Maintenance (NEm): energy in a feed used to keep an animal in energy equilibrium, neither gaining weight nor losing weight

Net Energy for Gain (NEg):energy in a feed used for body weight gain once maintenance is achieved

Energy- Net Energy

- Generally, more precise then **TDN** when predicting forage energy, but must be used together



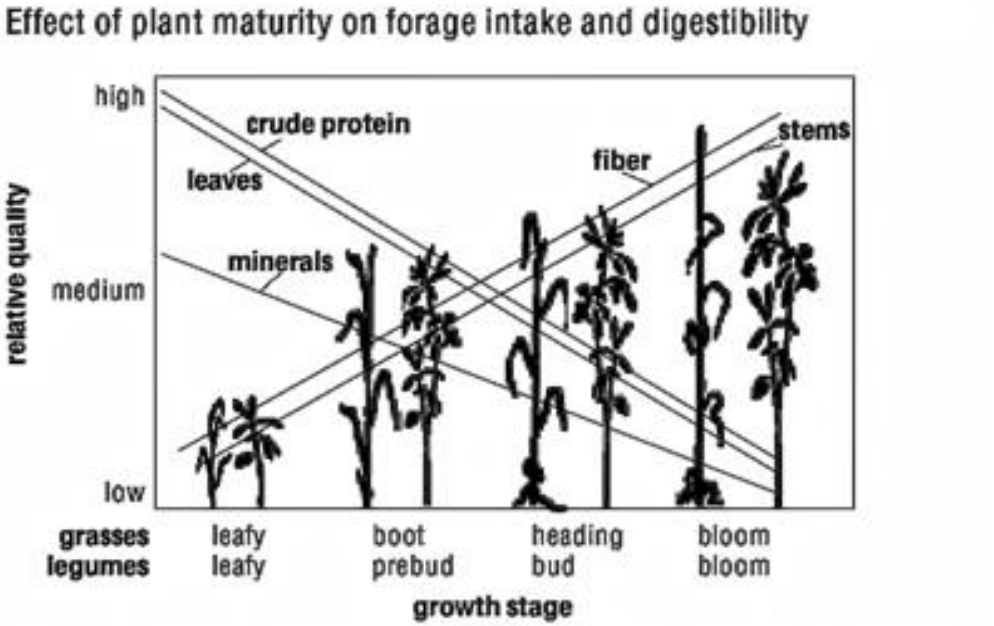
Nutrient Requirements for a 1,200 lb. mature beef cow

Stage of Production	NEm (Mcal/lb.)
2nd Trimester of Pregnancy	0.44
3rd Trimester of Pregnancy	0.50
1st 90 days of lactation after calving (20 lbs./day milk)	0.56

*Derived form *Nutrient requirements of Beef Cattle* (2000)

Other Calculated Values: RFV & RFQ

- Relative Feed Value (RFV) & Relative Forage Quality (RFQ)



Source: *Adapted from Blaser, R., R.C. Hammes, Jr., J.P. Fontenot, H.T. Bryant, C.E. Polan, D.D. Wolf, F.S. McClaugherty, R.G. Klein, and J.S. Moore. 1986. Forage–animal management systems. Virginia Polytechnic Institute, Bulletin 86-7.*

Account No. : [redacted]

NIR Analysis Report

[redacted]

Invoice No. : [redacted]
Date Received : 10/05/2023
Date Reported : 10/09/2023

Lab Number : 13126

Results For : [redacted]
Sample ID :
Description : GRASS HAY

	Analysis As Received	Analysis Dry Basis
Moisture, %	14.24	0.00
Dry Matter, %	85.76	100.00
PROTEIN		
Crude Protein, %	7.1	8.2
FIBERS		
Acid Detergent Fiber, %	32.0	37.3
Neutral Detergent Fiber, %	54.3	63.3
NDFD (digestibility) 48 hr, % of NDF		53
IVTDMD (in vitro true digestibility) 48 hr, %	61.1	71.2
ENERGIES		
TDN Est., %	51.4	60.0
Net Energy Lact, MCal/lb	0.5260	0.6134
Net Energy Maint, MCal/lb	0.5102	0.5949
Net Energy Gain, MCal/lb	0.2870	0.3347
QUALITY VALUE		
Relative Feed Value		88
Relative Forage Quality		127
MINERALS		
*Calcium, % Ca	0.37	0.43
*Phosphorus, % P	0.10	0.12
*Potassium, % K	1.20	1.40
*Magnesium, % Mg	0.14	0.16
*Zinc, ppm Zn	22.0	25.6
*Iron, ppm Fe	256	298
*Manganese, ppm Mn	146	171
*Copper, ppm Cu	4.6	5.3
*Sulfur, % S	0.13	0.15
*Sodium, % Na	0.01	0.01
*Molybdenum, ppm Mo	0.94	1.09
Ash, %	2.10	2.45
OTHER ANALYSIS		

RFV & RFQ

- **Relative Feed Value** was developed first
- **Relative Forage Quality** came later as an improvement
- Used to rank forages according to overall nutritive value

RFV & RFQ

- Both are compared to the average score of full bloom alfalfa

Full Bloom Alfalfa RFV & RFQ = 100

Relative Feed Value (RFV)

- Calculated based on **NDF** and **ADF**

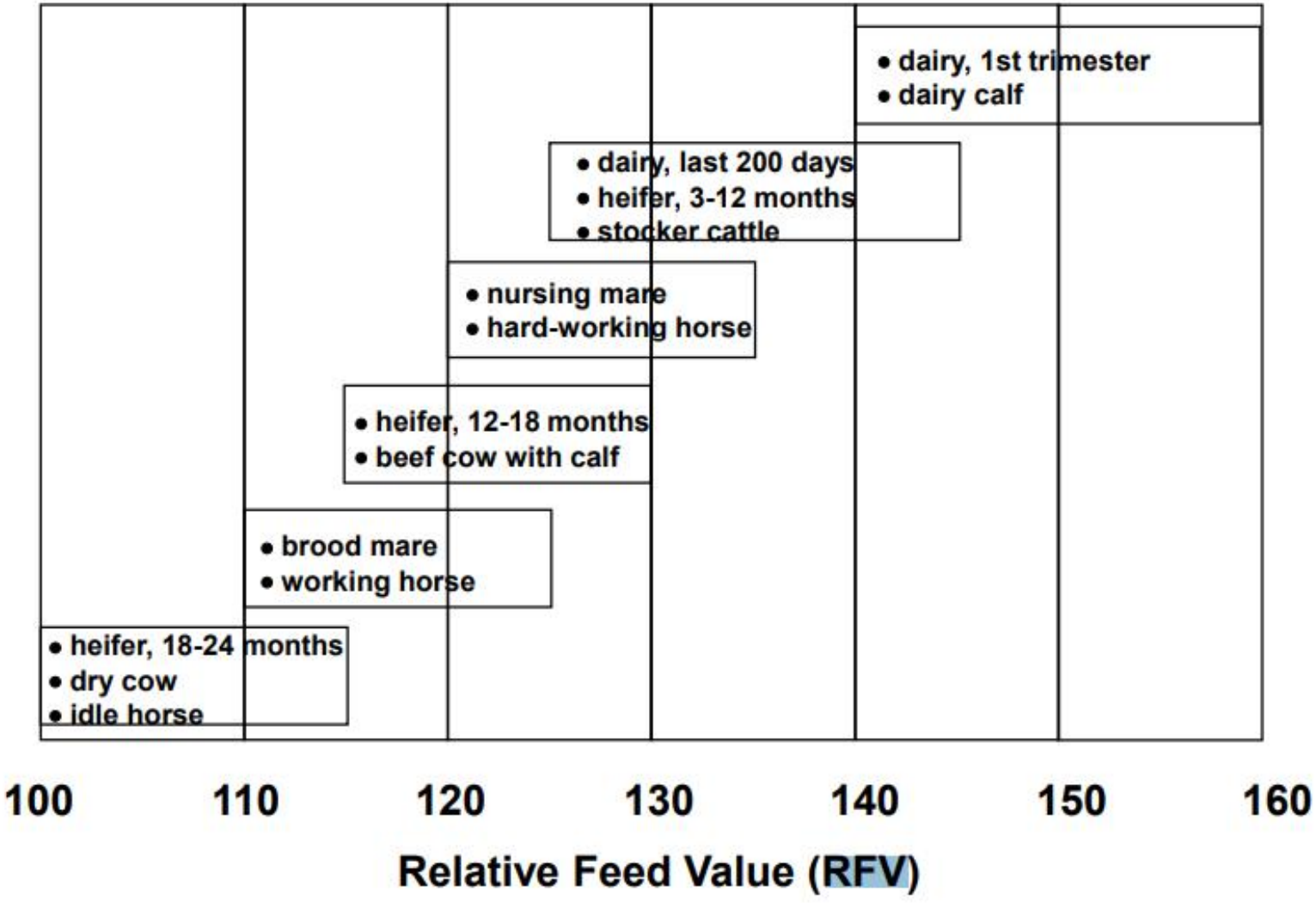
Digestible Dry Matter (DDM)= 88.9 - (0.779 * %ADF)

Dry Matter Intake (DMI)= 120 / %NDF

RFV = (DDM * DMI) / 1.29

- *Doesn't allow for comparison across forage types (cool season vs. warm season vs. legumes)

Forage quality needs of cattle and horses



Adapted from Undersander et al., 1994

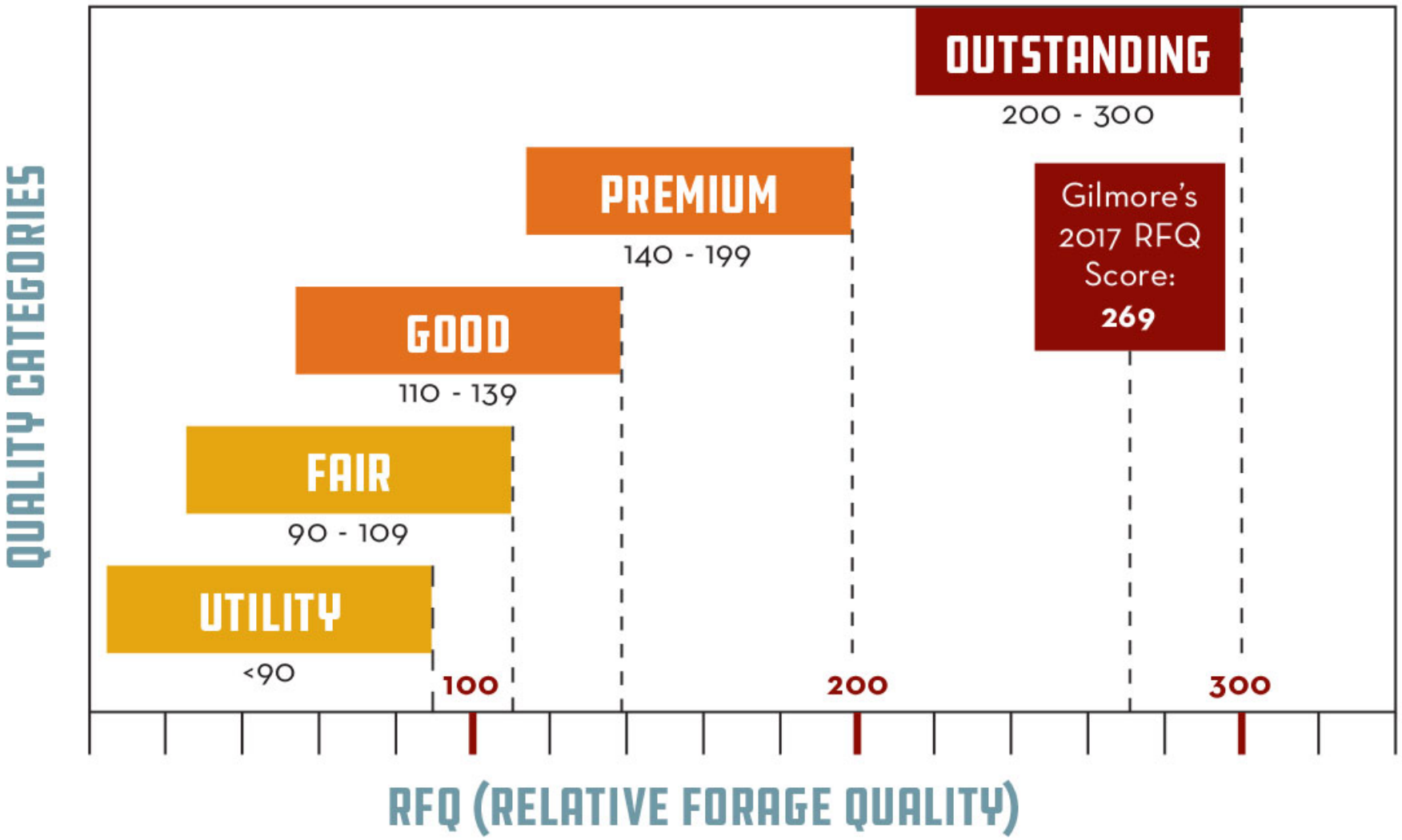
Relative Forage Quality (RFQ)

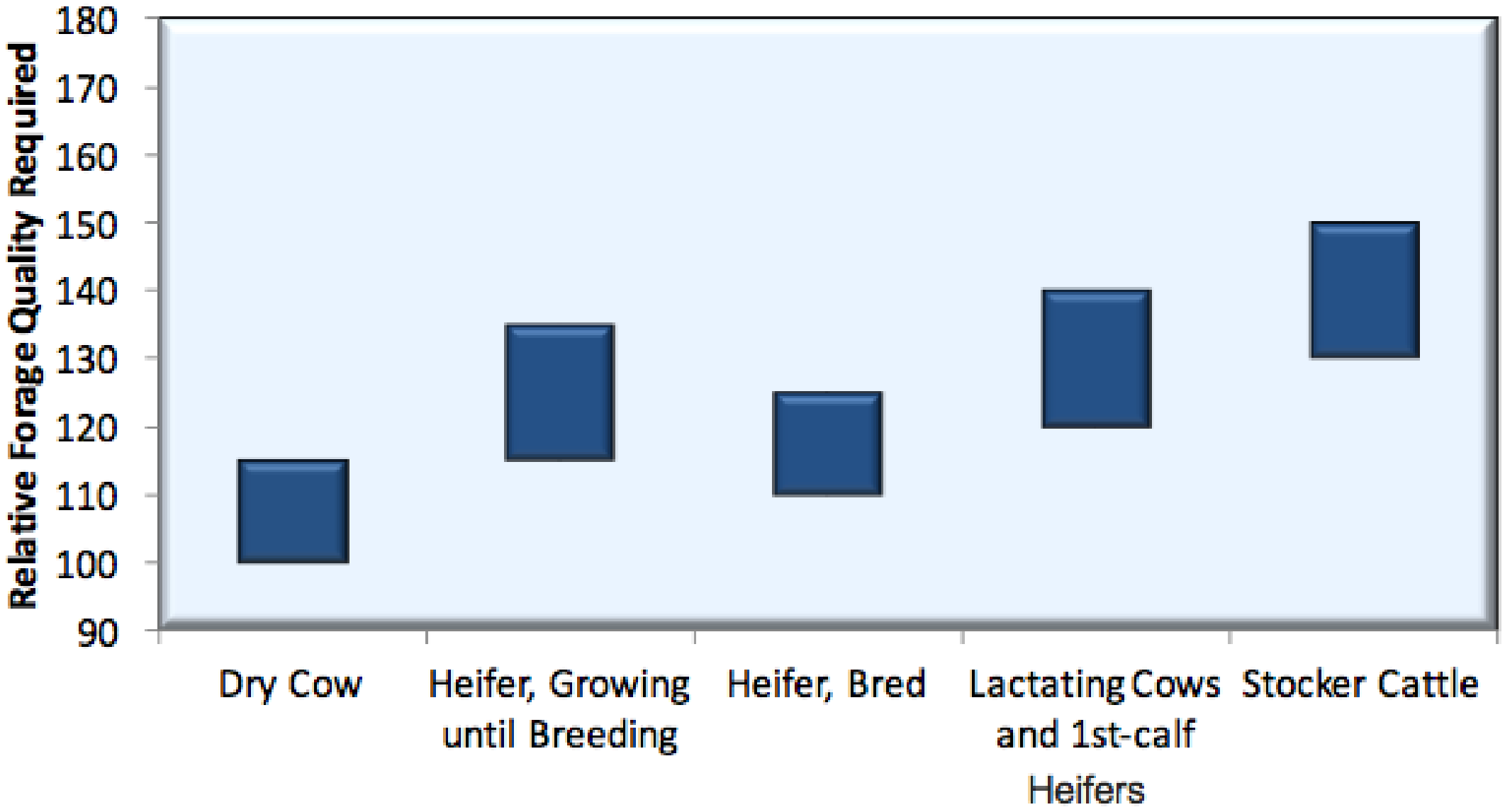
- Uses **TDN** as part of the calculation

RFQ = DMI (% of BW) × (TDN (% of DM) ÷ 1.23

- More useful for comparison and pricing
- Comparison between forage types
- Ranges from 50 to 250

RELATIVE FORAGE QUALITY FOR HAY




Relative Forage Quality Required
180
170
160
150
140
130
120
110
100
90
Dry Cow
Heifer, Growing until Breeding
Heifer, Bred
Lactating Cows and 1st-calf Heifers
Stocker Cattle

Macrominerals: Calcium (Ca) & Phosphorous (P)

- % of DM
- Critical for skeletal growth and lactation
  - ~2.85% of total body weight
- Ratio of Ca:P should be 1.5:1 to 2:1

Stage of Production	Calcium	Phosphorous
Dry Cows	0.25% to 0.30%	0.16% to 0.19%
Cows at Peak Lactation[a]	0.27% to 0.34%	0.18% to 0.21%
715 lb Yearling w/a 1,300 lb. finishing weight[b]	0.22% to 0.72%	0.13% to 0.34%

[a]Depends on milk production

[b] Depends on ADG

Conclusion

- Hay analysis can be a great tool when understood
  - >Are requirements being met?
  - >Supplementation needs
  - >Pricing Hay

Conclusion

- Learn how to condense the data from report
  - >Some values extremely important
  - >Others not as crucial

Thank you!

Call, email or drop by for more questions or for help sampling/testing

Dagan Montgomery, Extension Educator

(307) 367-4380

dmontgo8@uwyo.edu