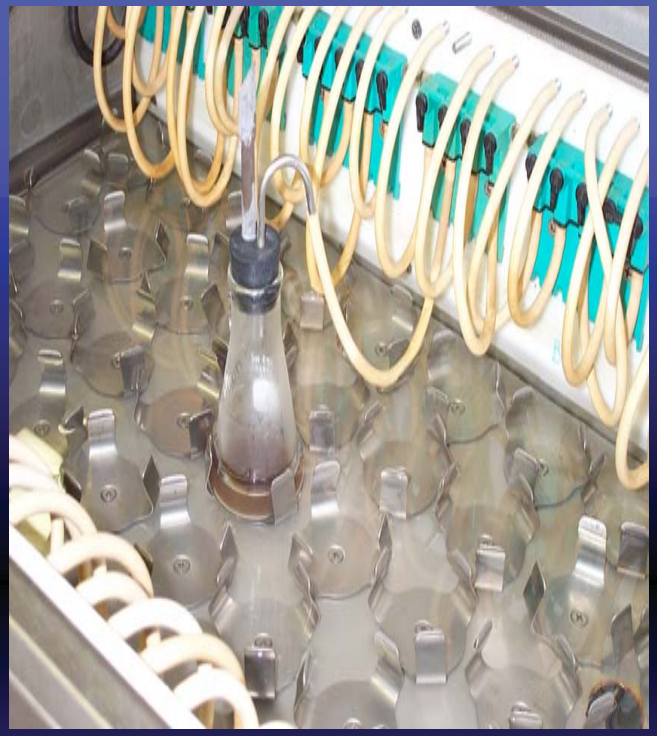


New Developments in Analytical Evaluation of Forages and Total Mixed Rations

P. C. Hoffman, R.D. Shaver
L.M. Bauman, T. M. Seeger
Dept. of Dairy Science
Dept of Soil Science
University of Wisconsin

20	*30*	*40*
CP	*ADF*	*NDF*

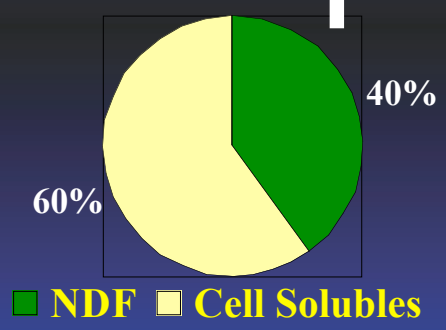
Forage Quality

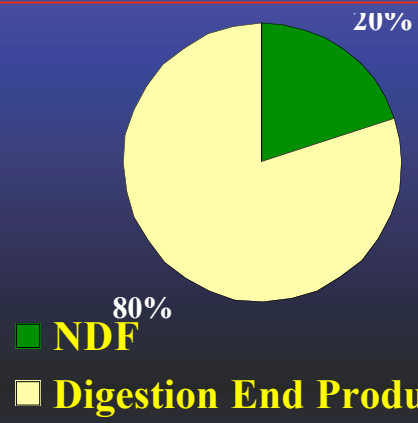
20	*40*	*50*
CP	*NDF*	*NDFD*

NDF Digestibility

DM and NDF Digestibility Procedures

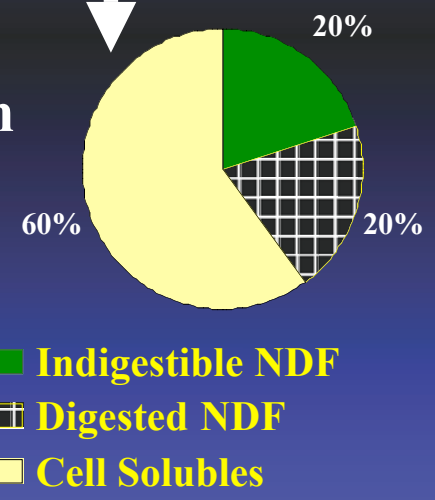
+ Buffers
+ Rumen Fluid





Incubate 30 or 48 h

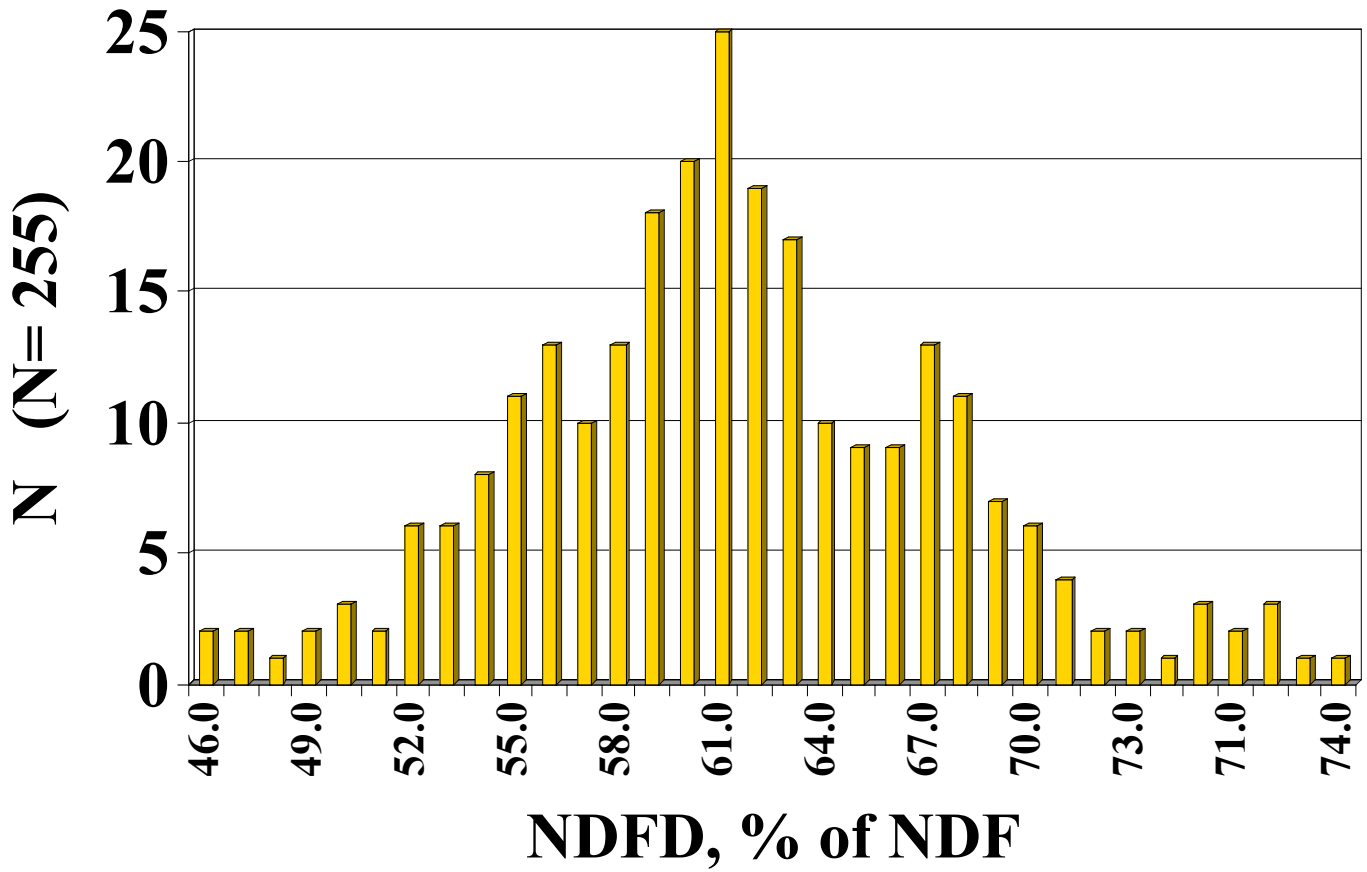
+ NDF Solution
+ Reflux

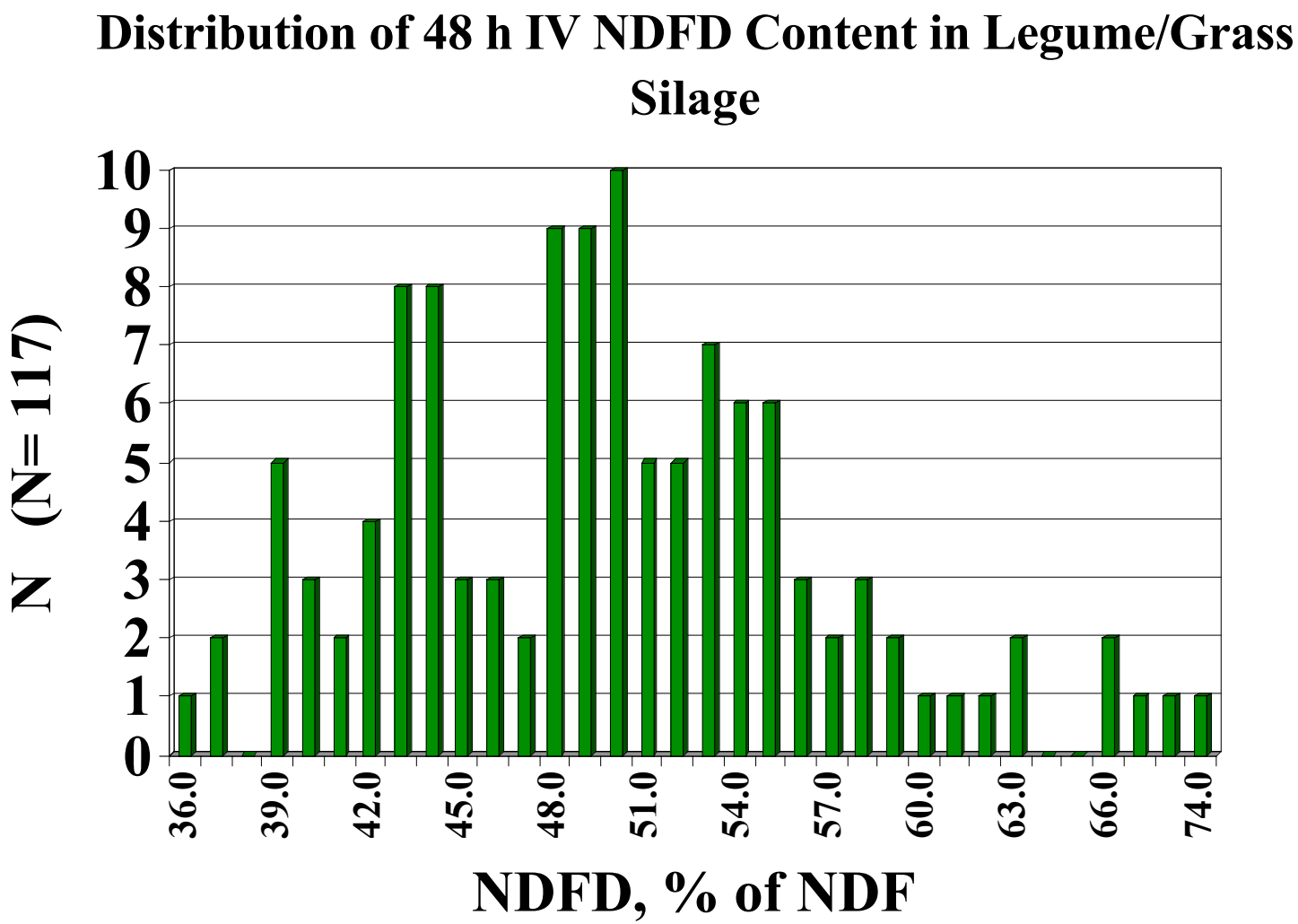


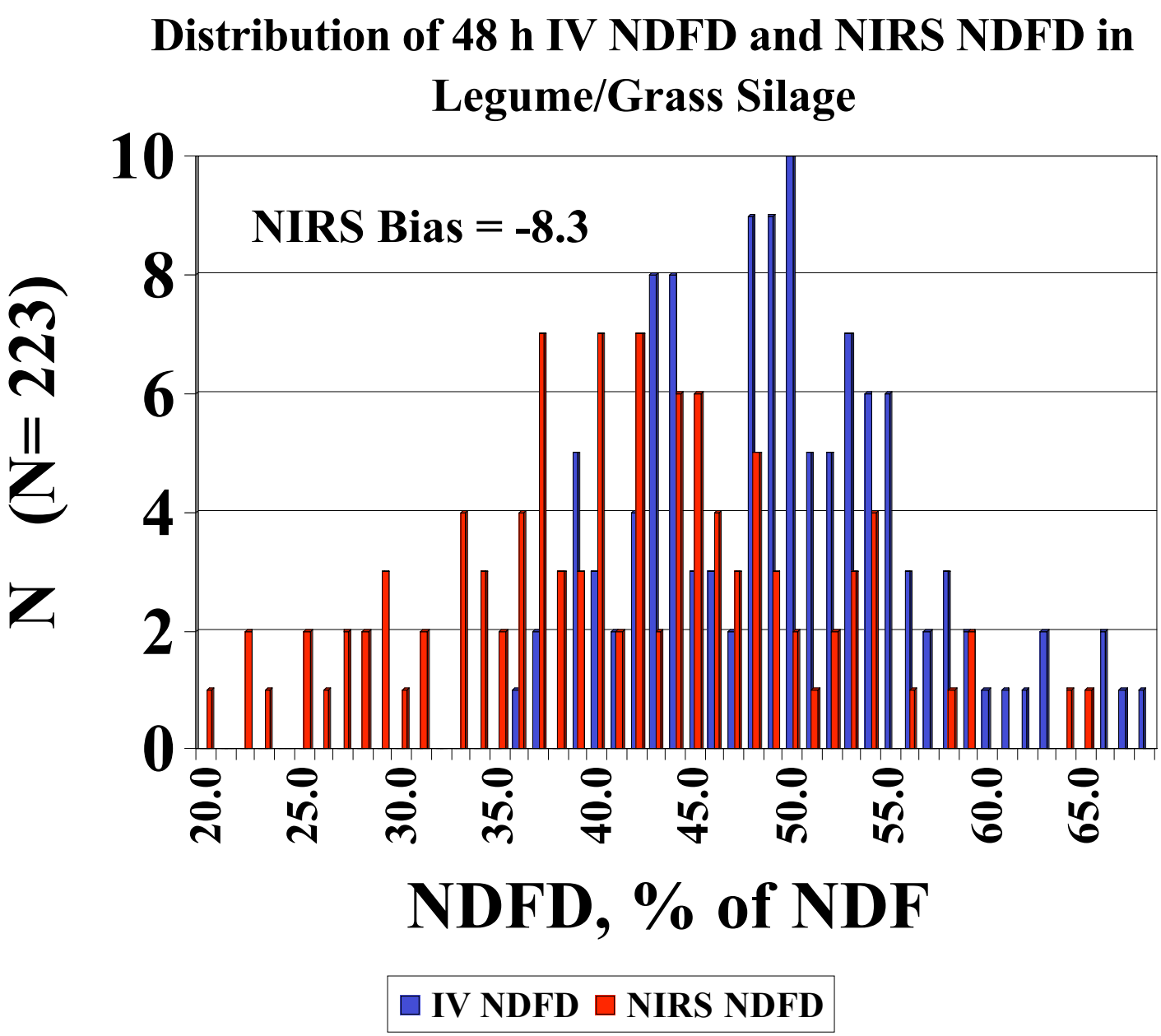
IVTDMD = Cell Solubles + Digested NDF (**80.0 % of DM**)

NDFD = Digested NDF/NDF (**50% of NDF**)

Distribution of 48 h IV NDFD Content in Corn Silage




Distribution of 48 h IV NDFD Content in Legume/Grass Silage
N (N= 117)
0
1
2
3
4
5
6
7
8
9
10
36.0
39.0
42.0
45.0
48.0
51.0
54.0
57.0
60.0
63.0
66.0
74.0
NDFD, % of NDF


Distribution of 48 h IV NDFD and NIRS NDFD in Legume/Grass Silage
NIRS Bias = -8.3
N (N= 223)
0
2
4
6
8
10
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
NDFD, % of NDF
IV NDFD
NIRS NDFD

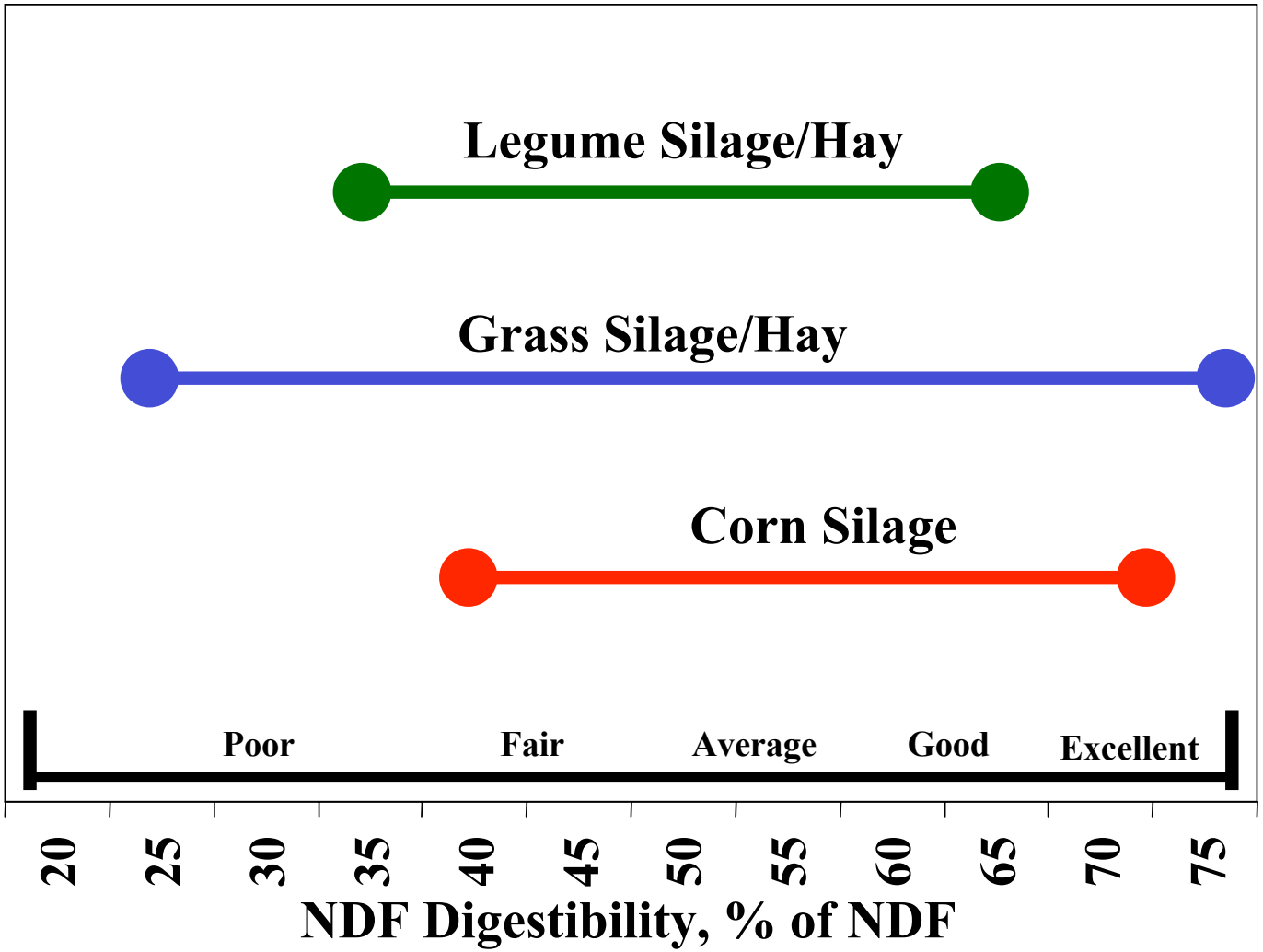
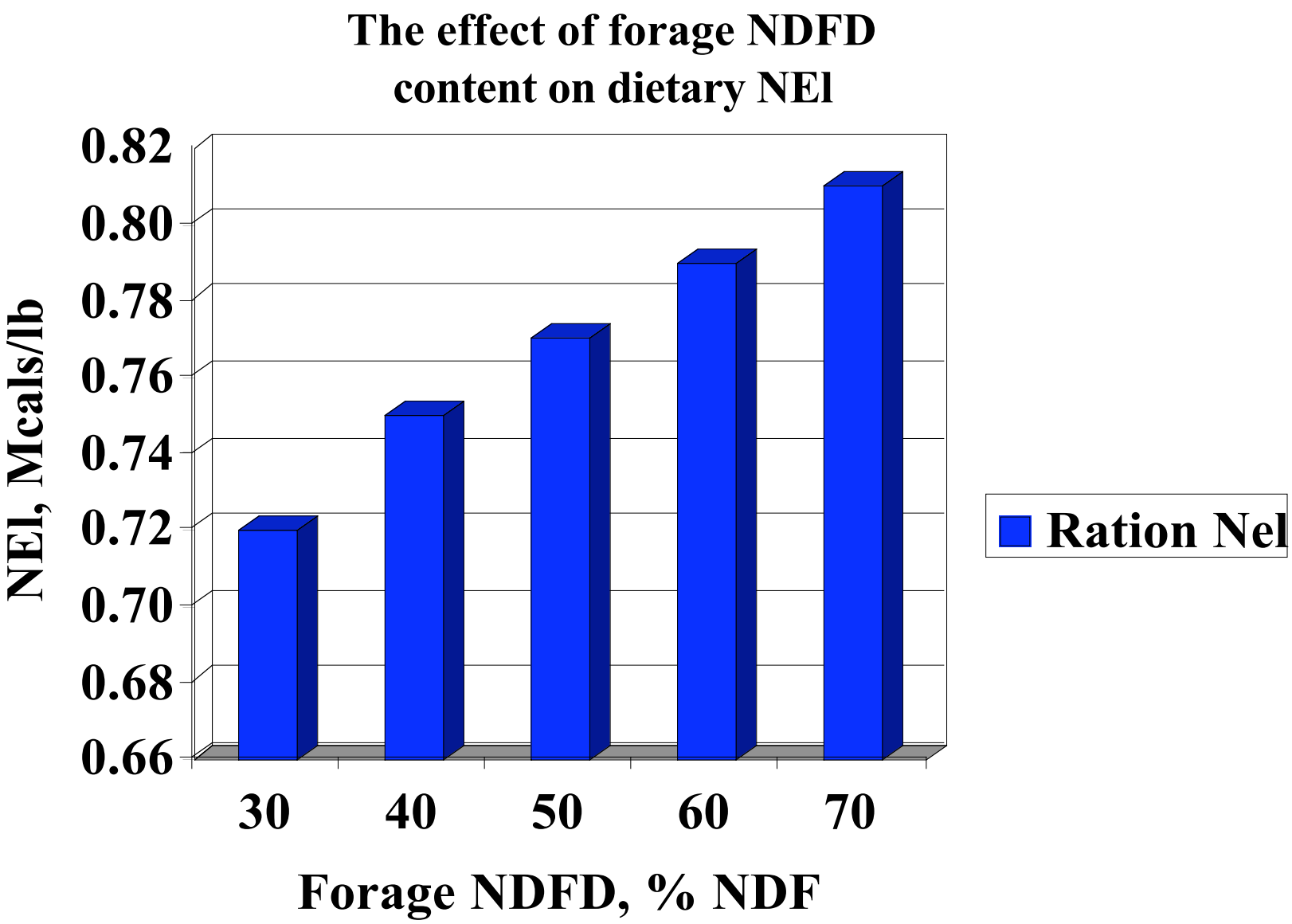
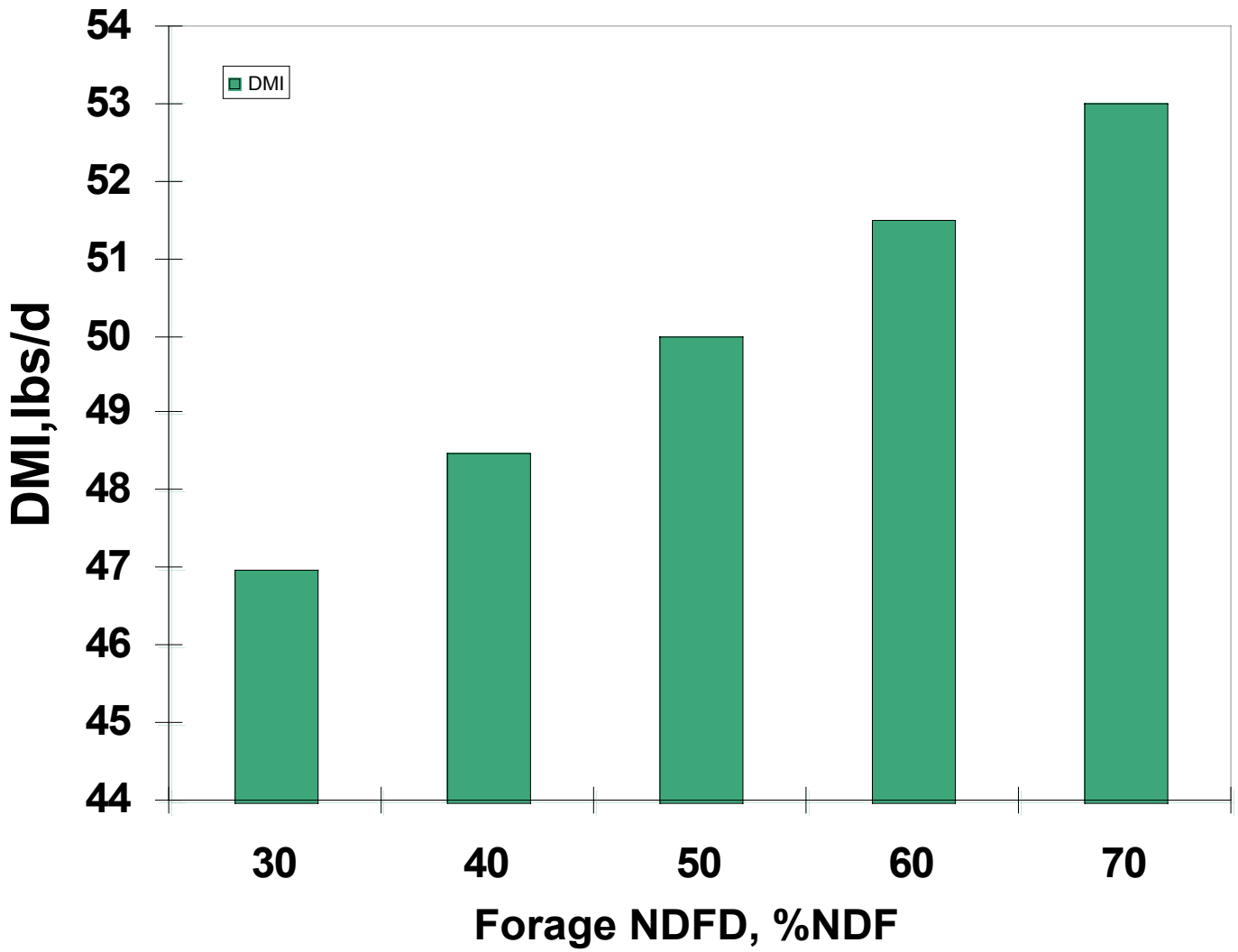


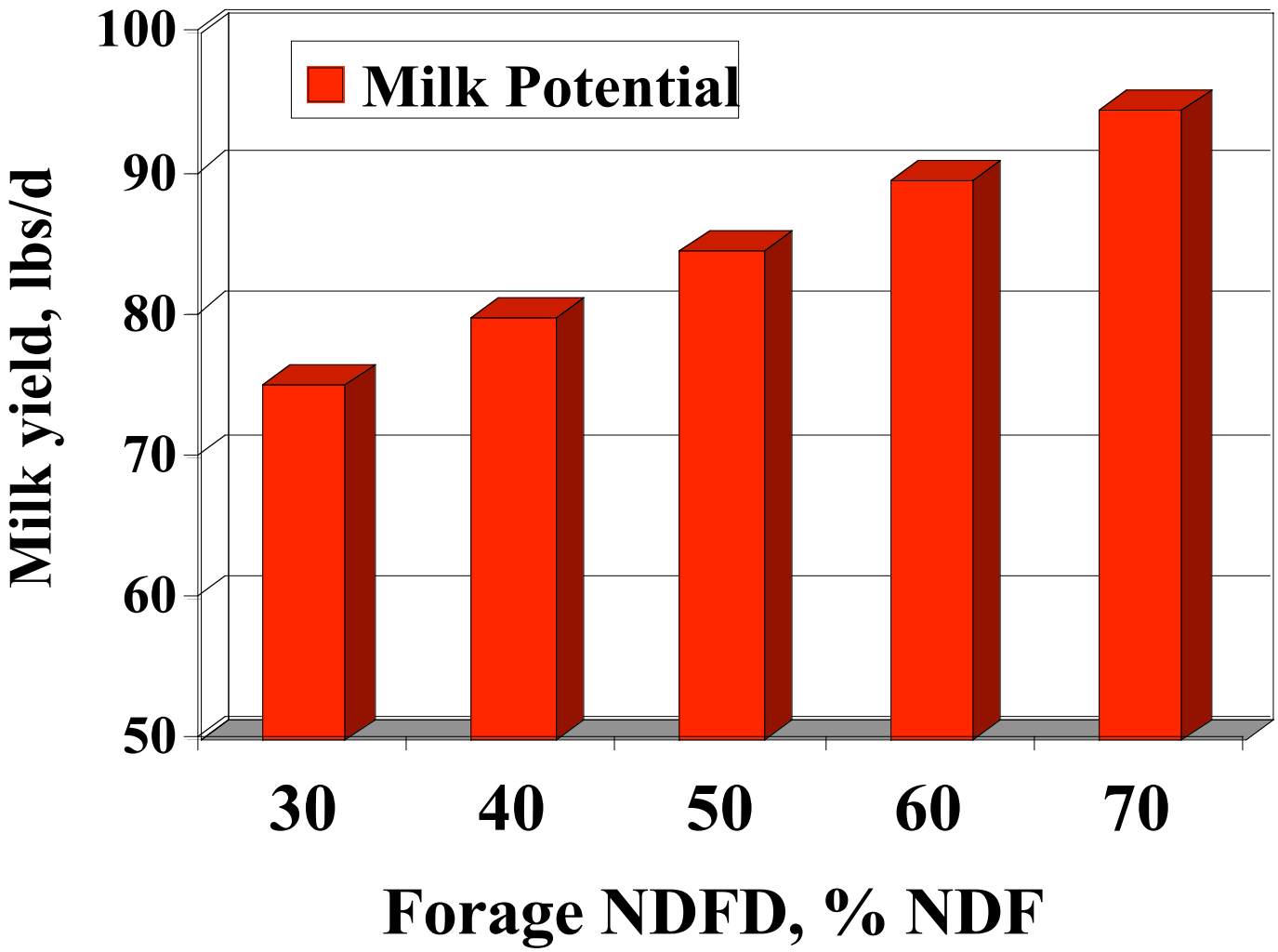
Figure 2. Ranges of NDF digestibility for common forages. The NDF digestibility ranges and guidelines are based on a 48 h in vitro true dry matter digestibility assay. (Marshfield Soil and Forage Analysis Laboratory, University of Wisconsin-Madison: 2001 Nutrient Requirements of Dairy Cattle).


The effect of forage NDFD content on dietary NEl
NEl, Mcals/lb
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0.68
0.66
30
40
50
60
70
Forage NDFD, % NDF
Ration Nel

The effect of forage NDFD on diet DM and Nel intake



The effect of forage NDFD content on milk yield potential



Low NDFD Forage & High-Fiber Byproduct

Item	High NDFD lb DM/d	Low NDFD lb DM/d	Adj. Low NDFD lb DM/d
Alfalfa (45 vs 35 NDFD)	20	18.6	18.6
Corn Silage (58 vs 48 NDFD)	12	11.2	11.2
Concentrate	26	24.4	24.4
Beet Pulp or Soy Hulls	--	--	4.0
DMI	58	54	58
NDF%	31.7	31.7	32.7 - 33.7
NFC%	41.5	41.5	39.9 - 41.5

Low NDFD Forage & High-Fiber Byproduct

NRC-01	High NDFD lb/d	Low NDFD lb/d	Adj. Low NDFD lb/d
NE Allowable Milk	100	92	98
MP Allowable Milk	104	96	103

NDF, NDFD & dNDF of Selected High-Fiber Byproducts[1]

Ingredient	NDF, %DM[2]	NDFD,%NDF	dNDF, %DM
Forages	40 - 60	30 - 60	10 - 35
CGF	36	80 (1)	29
DDG	39	75 (14)	29
Brewers	47	50 (2)	24
Wheat Midds	37	50 (3)	19
Beet pulp	46	85 (10)	39
Citrus pulp	24	85 (2)	20
Soy hulls	60	90 (2)	54
WCS	50	50 (36)	25
CS Hulls	85	20 (4)	17
Almond Hulls	37	40 (5)	15

[1]30-h in vitro adapted from Peter Robinson, CA-Davis. [2]*NRC-01.*

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MARS

Acct. Number
Date ##

Comments

Alfalfa Silage - Microwave

Lab Number 3741 ***Sample Description*** SILO 1

Item	*Abreviation*	*Unit*	*Value*	*Method*[1]
Dry Matter	*DM*	*% as fed*	50.0	*WC*
Moisture		*% as fed*	50.0	*WC*
Protein Fractions				
Crude Protein	*CP*	*% of DM*	18.0	*NIR*
Acid Detergent Fiber Crude Protein	*ADF-CP*	*% of DM*	1.10	*NIR*
Adjusted Crude Protein		*% of DM*	18.0	*C*
Fiber Fractions				
Acid Detergent Fiber	*ADF*	*% of DM*	32.1	*NIR*
Neutral Detergent Fiber	*aNDF*	*% of DM*	41.1	*NIR*

Energy Calculations:2001 NRC[2]

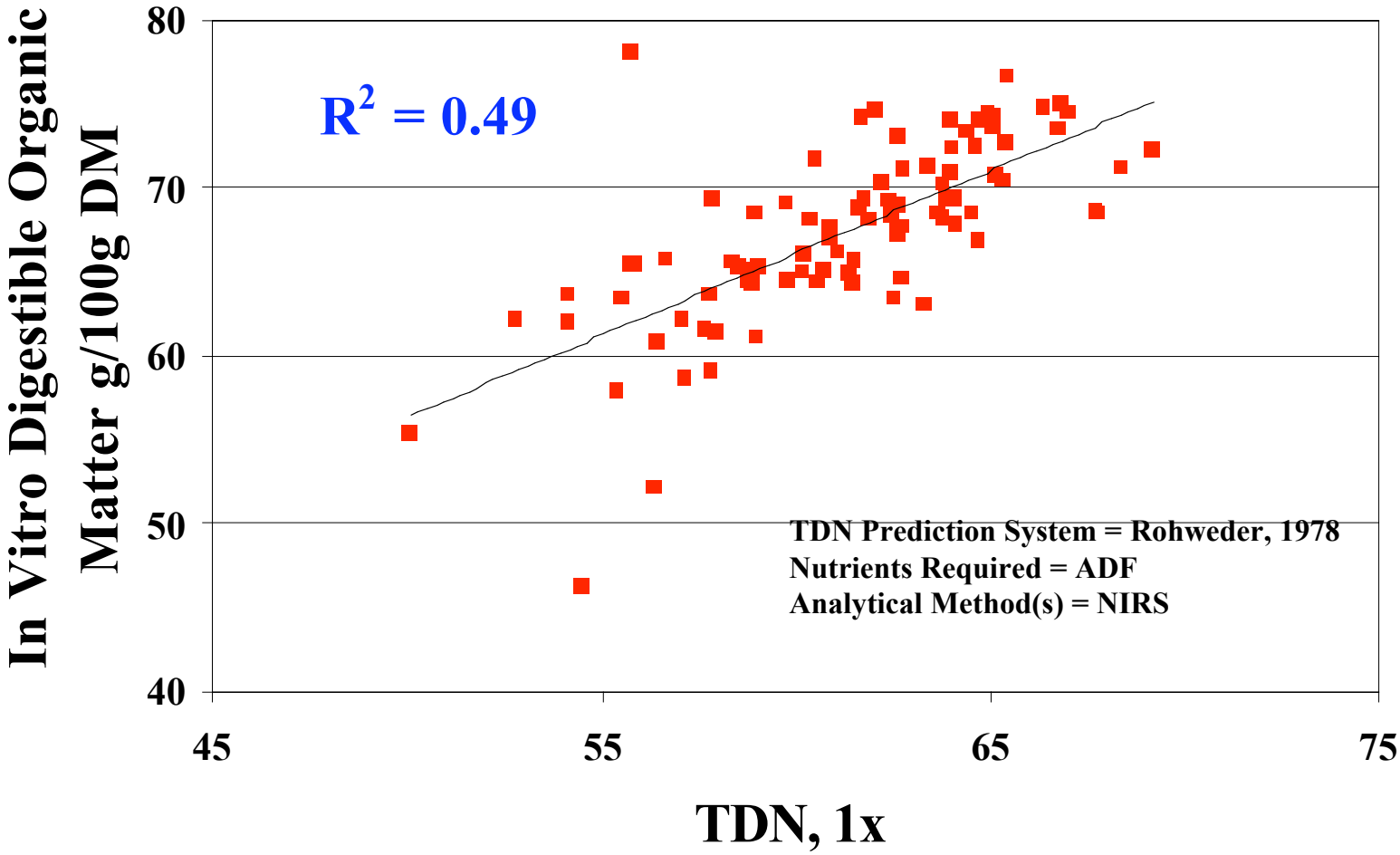
Macro Minerals					*Micro Minerals*			
Phosphorus	*P*	0.23	*% of DM*	*NIR*	*Iron*	*Fe*	*ppm*	*NR*
Calcium	*Ca*	1.14	*% of DM*	*NIR*	*Manganese*	*Mn*	*ppm*	*NR*
Potassium	*K*	2.98	*% of DM*	*NIR*	*Zinc*	*Zn*	*ppm*	*NR*
Magnesium	*Mg*	0.24	*% of DM*	*NIR*	*Copper*	*Cu*	*ppm*	*NR*
Sodium	*Na*		*% of DM*	*NR*				
Chloride	*Cl*		*% of DM*	*NR*	*Ash*		*%of DM*	*WC*
Sulfur	*S*		*% of DM*	*NR*				

[1] *WC = wet chemistry* *NR = not requested* *C = calculated*
NIR = near infrared spectroscopy *NA = not available*

1 Day Forage Analysis

Legume/grass silages

Lundberg and Hoffman,2003



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Acct # 555372
Date 8/8/2002

MARSHFIELD AG RESEARCH STATION
8396 YELLOWSTONE DRIVE
MARSHFIELD, WI 54449

Comments

Legume/Grass Silage- UW Recommended

Lab Number 3033 Sample Description SILO #6, 8/08/02

Item	Abbrev	Unit	Value	Method[1]
Dry Matter	DM	% as fed	47.93	WC
Moisture		% as fed	52.07	C
Protein Fractions				
Crude Protein	CP	% of DM	20.62	NIR
Soluble Crude Protein	SCP	% of CP	47.03	NIR
Rumen-Undegraded Protein	RUP	% of CP	22.29	NIR
Rumen-Degraded Protein	RDP	% of CP	77.71	C
Acid Detergent Fiber Crude Protein	ADF-CP	% of DM	1.05	NIR
Neutral Detergent Fiber Crude Protein	NDF-CP	% of DM	4.30	NIR
Heat Damaged Protein-Estimated		% of DM	1.05	C
Adjusted Crude Protein		% of DM	20.62	C
Fiber Fractions				
Acid Detergent Fiber	ADF	% of DM	28.11	NIR
Neutral Detergent Fiber	aNDF	% of DM	36.40	WC
Lignin (Acid detergent)	ADL	% of DM	4.66	NIR
Neutral Detergent Fiber Digestibility, 48 h	NDFD	% of NDF	43.88	WC
NDF/Lignin Ratio			7.81	C
Carbohydrates and Fats				
Non Fiber Carbohydrate	NFC	% of DM	31.57	C
Fat		% of DM	3.20	C
pH			4.40	NIR
Energy Calculations; NRC, 2001				
Total Digestible Nutrients,1X	TDN	% of DM	47.92	C
Net Energy , Lactation, 3X	Nel	Mcals/lb	0.48	C
Net Energy , Maintenance	NEm	Mcals/lb	0.38	C
Net Energy , Gain	NEg	Mcals/lb	0.14	C
Metabolizable Energy	ME	Mcals/lb	0.76	C
Relative Feed Value	RFV		170.44	C
Milk/Ton		lbs	1715	C

4-5 Day Forage Analysis

Macro Minerals

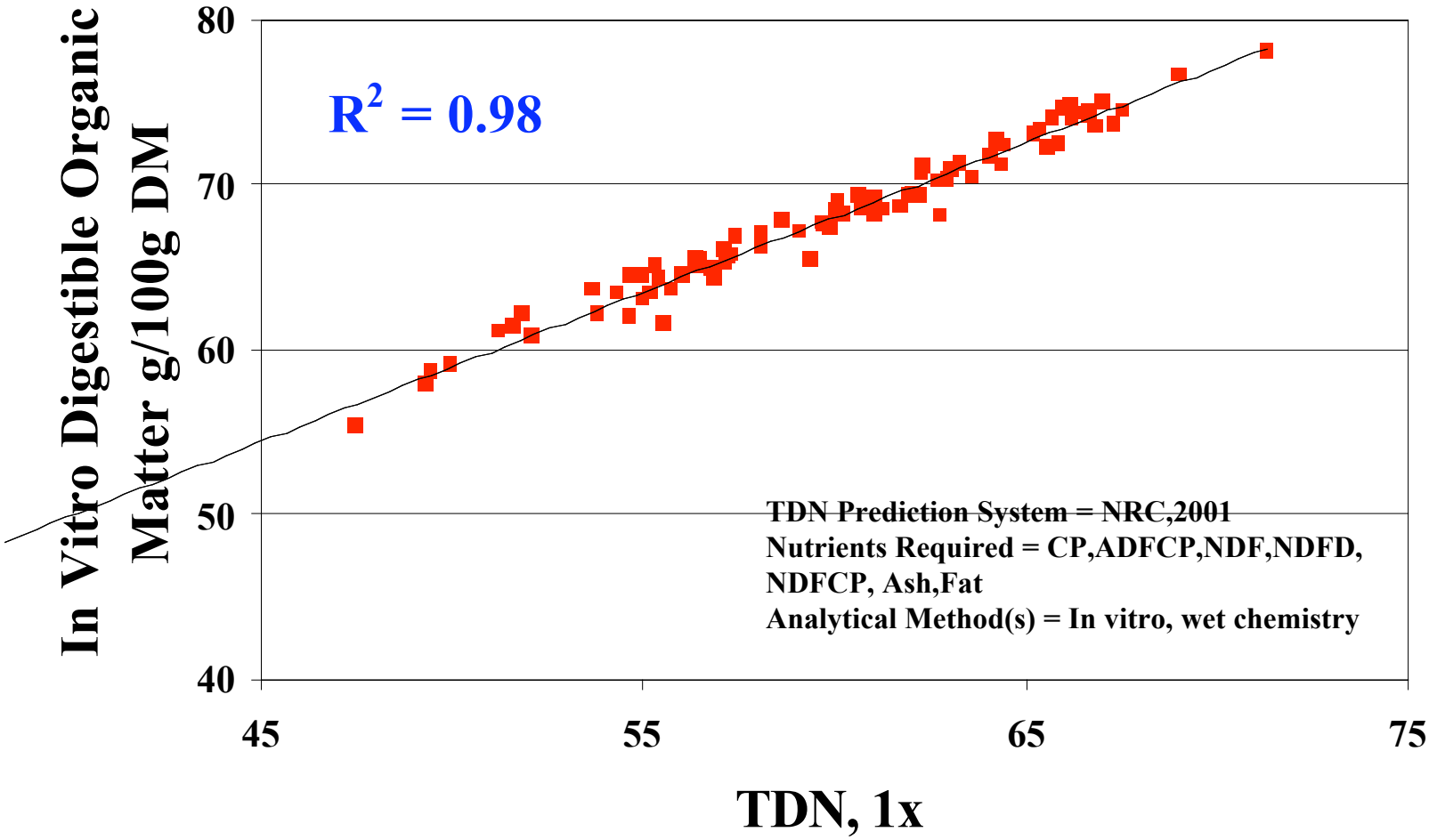
Phosphorus	P	0.23	% of DM	WC
Calcium	Ca	1.22	% of DM	WC
Potassium	K	2.19	% of DM	WC
Magnesium	Mg	0.37	% of DM	WC
Sodium	Na		% of DM	NR
Chloride	Cl		% of DM	NR

Micro Minerals

Iron	Fe		ppm	NR
Manganese	Mn		ppm	NR
Zinc	Zn		ppm	NR
Copper	Cu		ppm	NR
Ash		12.51	%of DM	WC

Legume/grass silages

Lundberg and Hoffman,2003



TMR – Quality Control Analysis

Corn Silage ↓ Alfalfa Silage

Forage Test

↓

Ration Formulation

* Computer Models
* Experience

Corn Silage | Alfalfa Silage

Forage Test

Ration Formulation

* Computer Models
* Experience

INCORRECT ASSUMPTIONS

Instruction Sheets
Communication
Unloaders
Loaders
Add Grains
Add Proteins/Byproducts
Add Dry Hay
Add Liquid Feeds

Add Minerals
Add Feed Additives
Pre Processing
DM Changes
Contamination
Mixing
Delivery Feed

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Comments

4-5 Day Laboratory Analysis

TMR- Quality Control

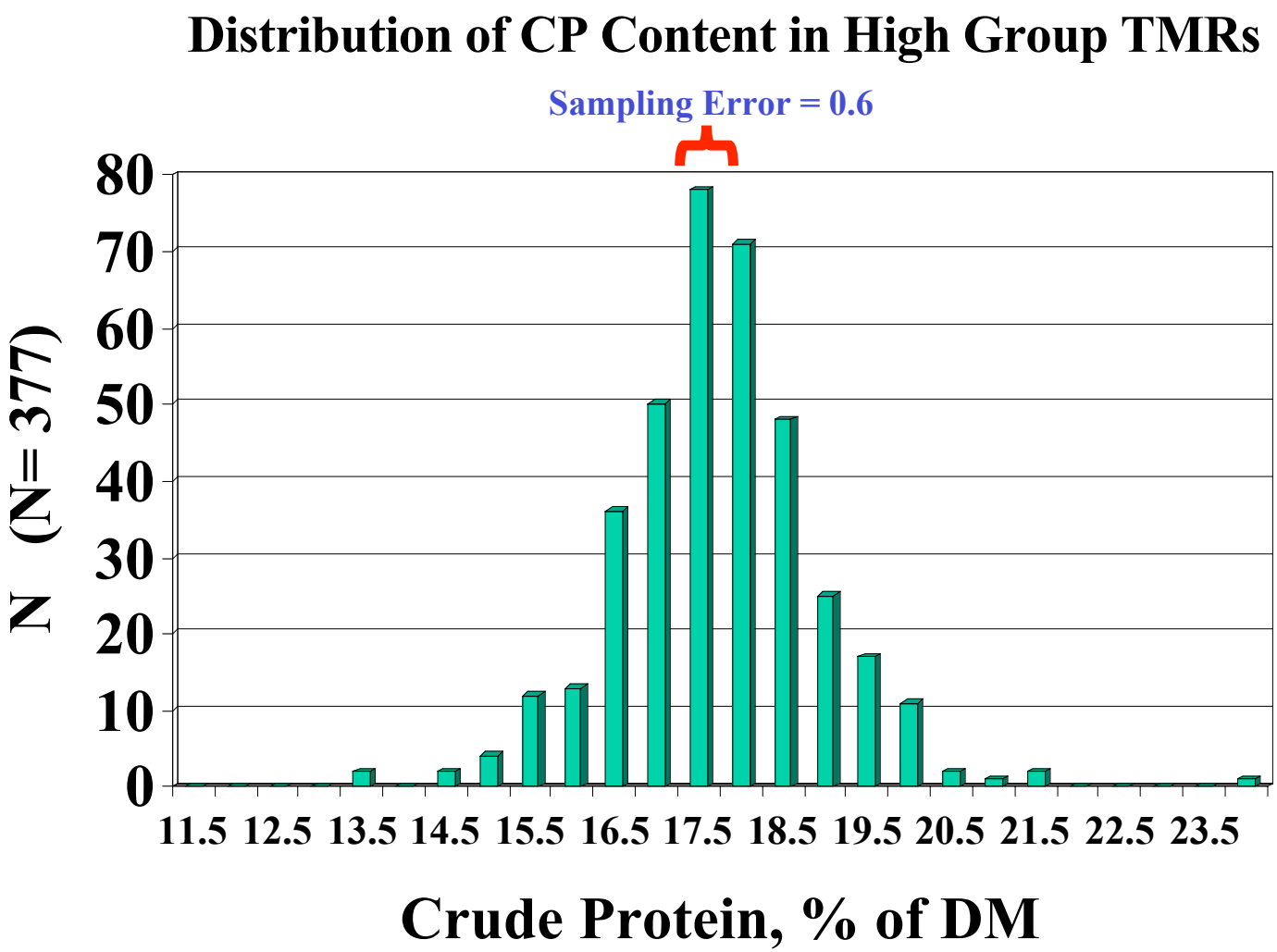
Lab Number 1459 Sample Description TMR TEST

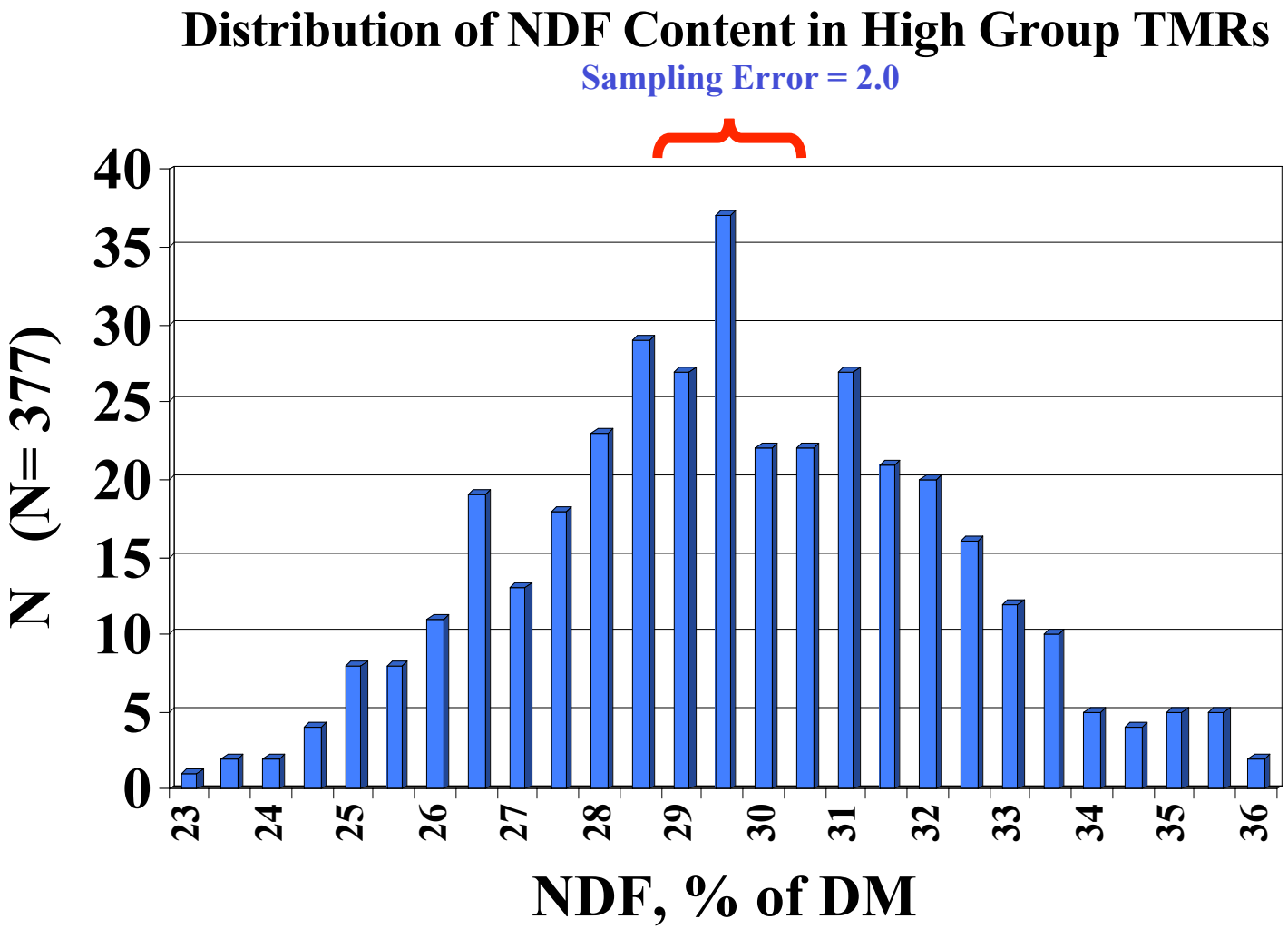
Item	Abreviation	Unit	Value	Method
Dry Matter	DM	% as fed	46.8	WC
Moisture		% as fed	53.2	WC
Protein Fractions				
Crude Protein	CP	% of DM	17.40	WC
Fiber Fractions				
Acid Detergent Fiber	ADF	% of DM		NR
Neutral Detergent Fiber	aNDF	% of DM	30.73	WC
Neutral Detergent Fiber Digestibiltiy 48 h	NDFD	% of NDF	60.77	WC
Carbohydrates and Fats				
Non Fiber Carbohydrate	NFC	% of DM	40.83	C
Fat		% of DM	4.54	WC

Energy Calculations:NRC,2001			**** Verified ****	
Total Digestible Nutrients,1X	TDN	% of DM	74.20	C
Net Energy , Lactation, 3X	Nel	Mcals/lb	0.76	C
Net Energy , Maintenance	NEm	Mcals/lb	0.85	C
Net Energy , Gain	NEg	Mcals/lb	0.56	C
Metabolizable Energy	ME	Mcals/lb	1.27	C

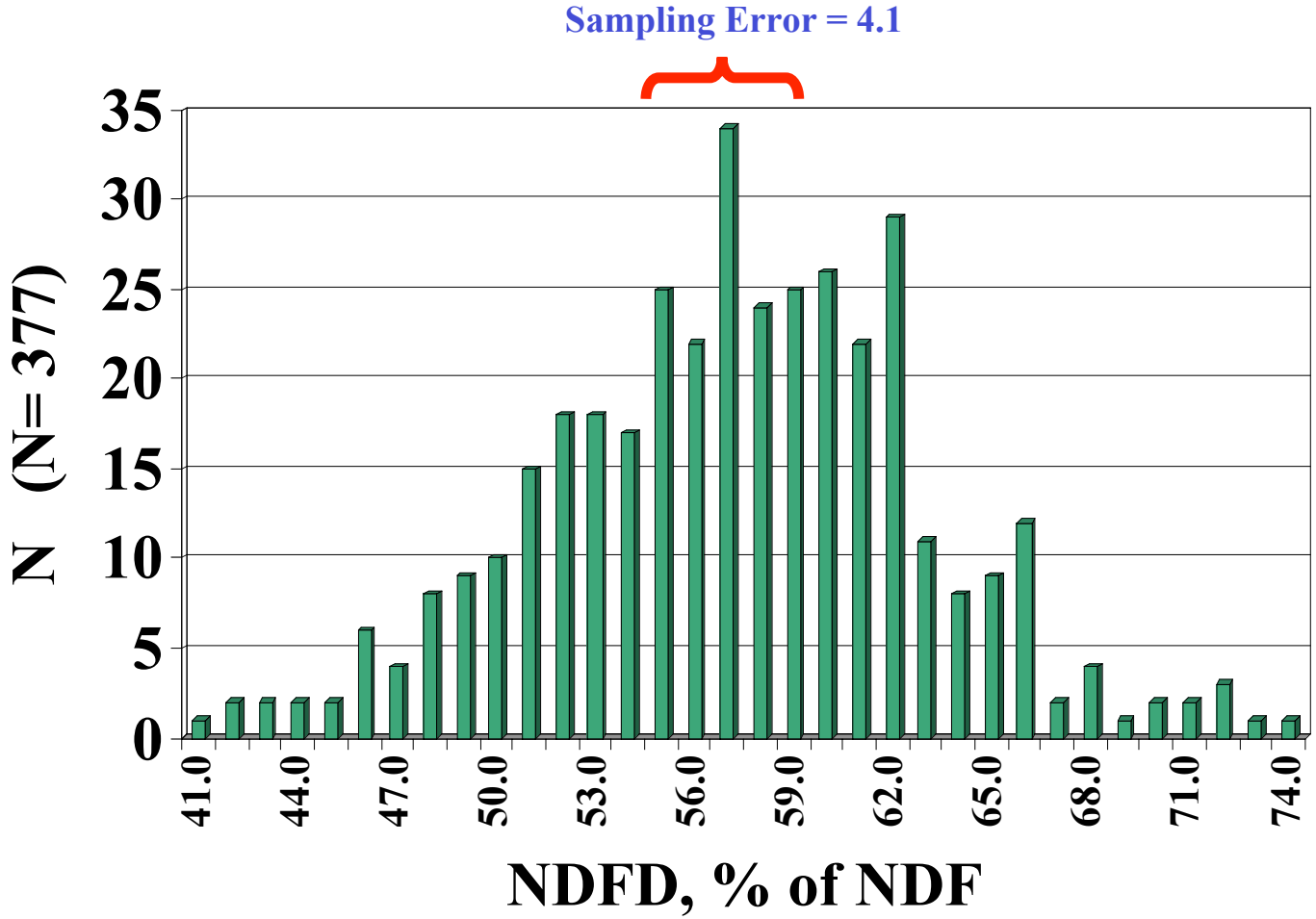
Macro Minerals				
Phosphorus	P	0.44	% of DM	WC
Calcium	Ca	0.91	% of DM	WC
Potassium	K		% of DM	NIR
Magnesium	Mg		% of DM	NIR
Sodium	Na		% of DM	NR
Chloride	Cl		% of DM	NR
Sulfur	S		% of DM	NR

Micro Minerals				
Iron	Fe		ppm	NR
Manganese	Mn		ppm	NR
Zinc	Zn		ppm	NR
Copper	Cu		ppm	NR
Ash		7.54	%of DM	WC


Distribution of CP Content in High Group TMRs
Sampling Error = 0.6
N (N= 377)
80
70
60
50
40
30
20
10
0
11.5 12.5 13.5 14.5 15.5 16.5 17.5 18.5 19.5 20.5 21.5 22.5 23.5
Crude Protein, % of DM

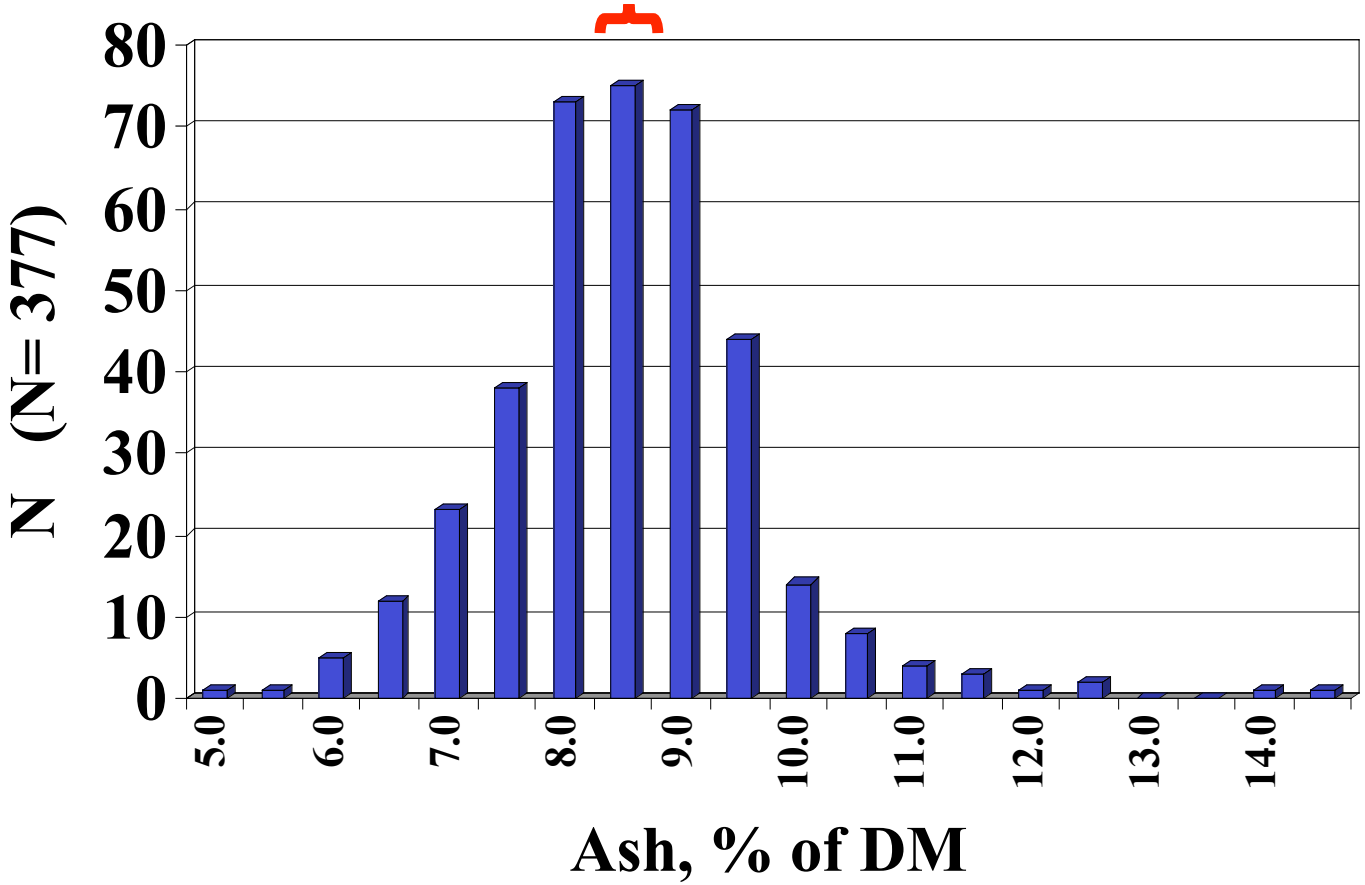

Distribution of NDF Content in High Group TMRs
Sampling Error = 2.0
N (N= 377)
40
35
30
25
20
15
10
5
0
23
24
25
26
27
28
29
30
31
32
33
34
35
36
NDF, % of DM

Distribution of NDFD Content in High Group TMRs



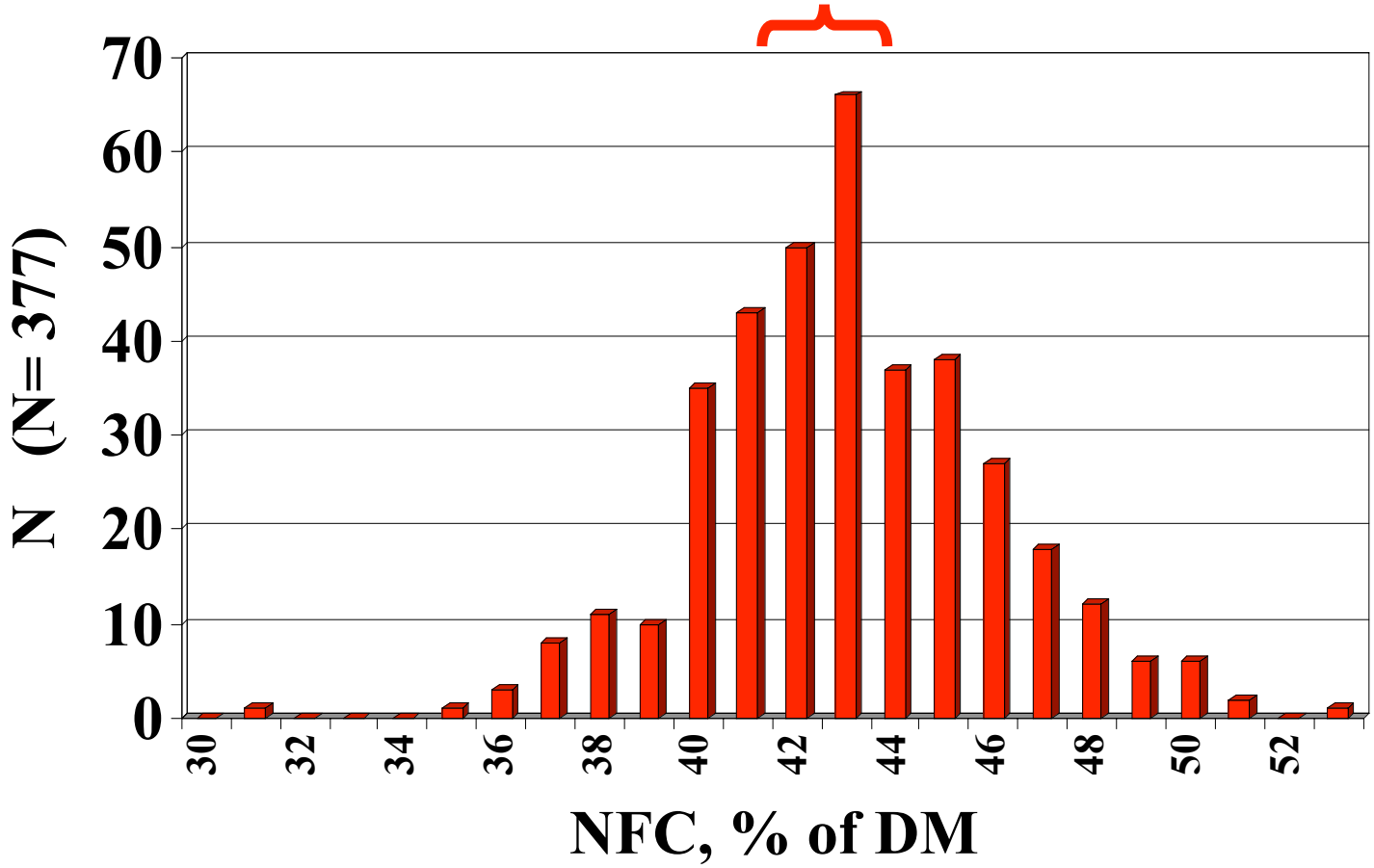
Distribution of Ash Content in High Group TMRs

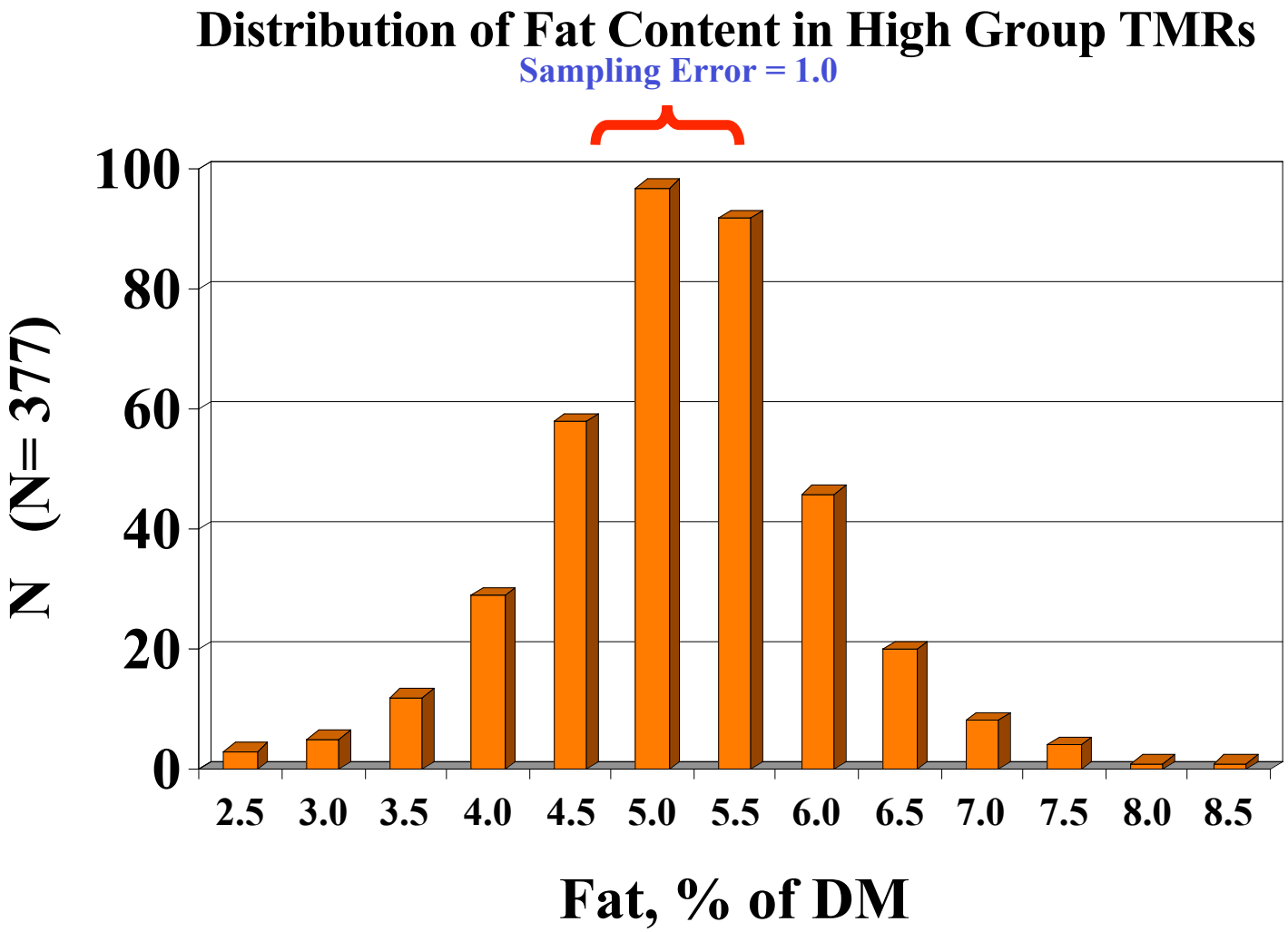
Sampling Error = 0.4



Distribution of NFC Content in High Group TMRs

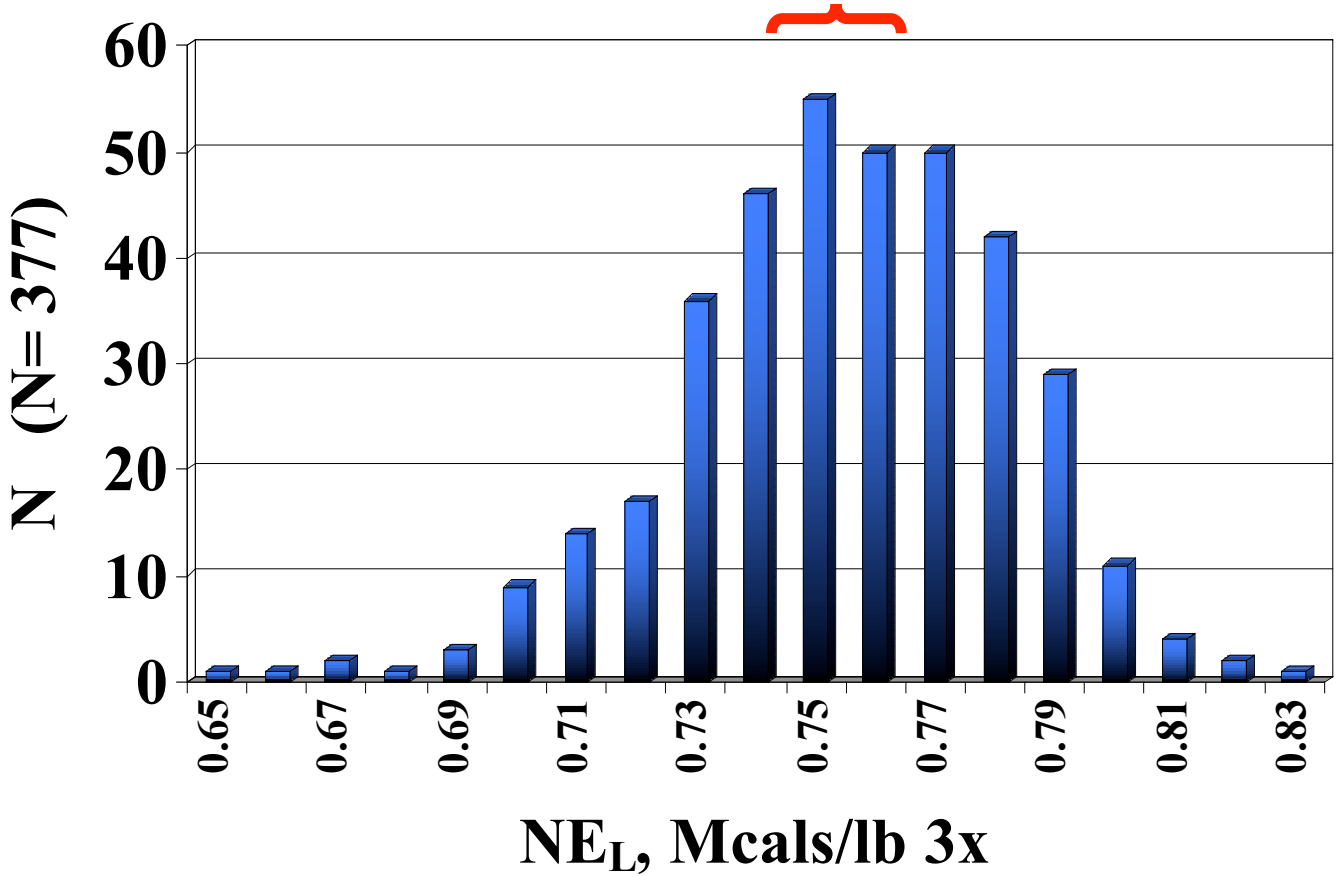
Sampling Error = 2.9




Distribution of Fat Content in High Group TMRs
Sampling Error = 1.0
N (N= 377)
100
80
60
40
20
0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Fat, % of DM

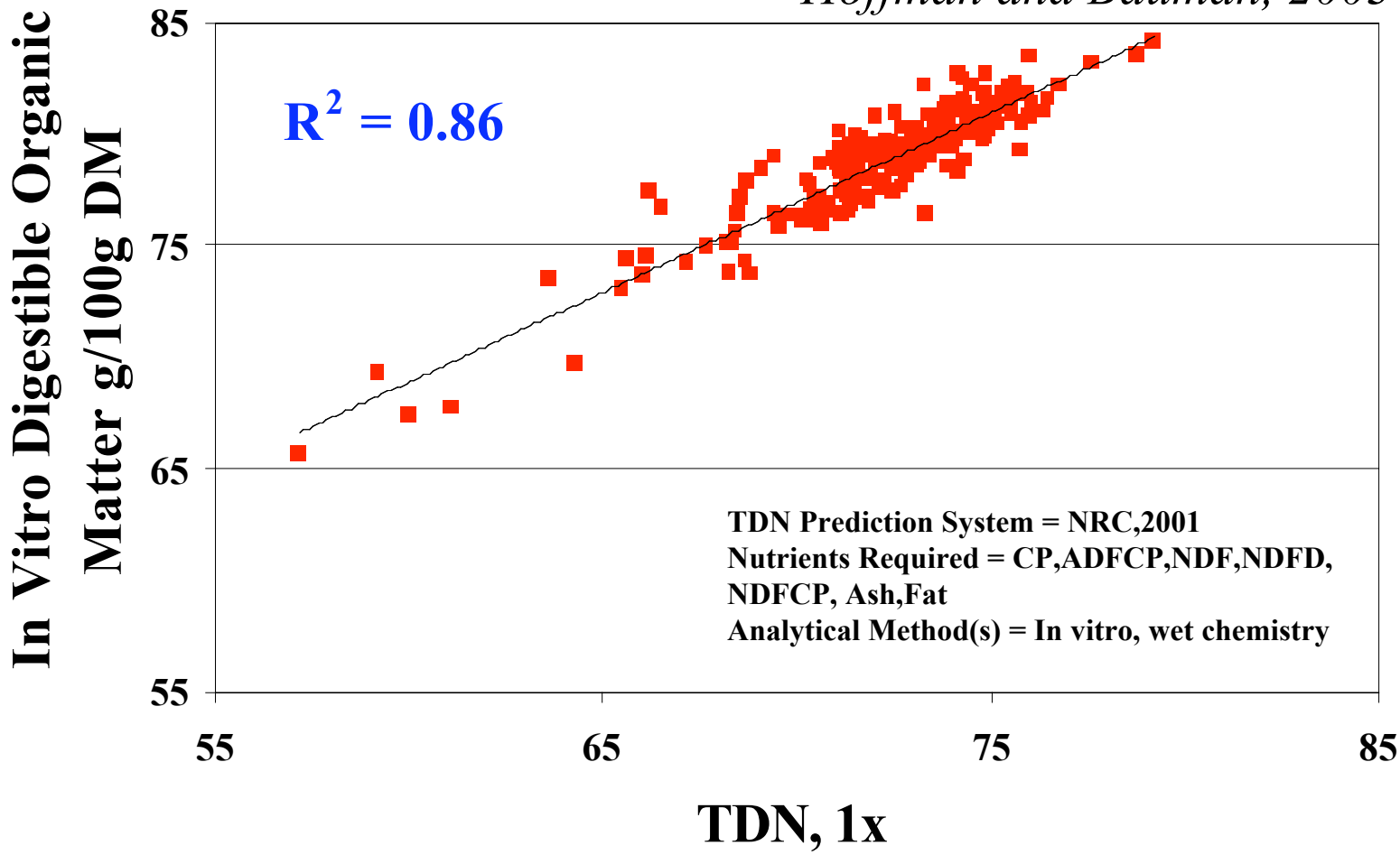
Distribution of NE_L Content in High Group TMRs

Sampling Error = .026



Total Mixed Rations (MARS TMR Quality Control Analysis)

Hoffman and Bauman, 2003



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Date ######

MARS

Comments

TMR- Quality Control

Lab Number 1459 *Sample Description* TMR TEST

Item	Abreviation	Unit	Value	Method[1]
Dry Matter	DM	% as fed	46.8	WC
Moisture		% as fed	53.2	WC
Protein Fractions				
Crude Protein	CP	% of DM	17.40	WC
Fiber Fractions				
Acid Detergent Fiber	ADF	% of DM		NR
Neutral Detergent Fiber	aNDF	% of DM	30.73	WC
Neutral Detergent Fiber Digestibiltiy 48 h	NDFD	% of NDF	60.77	WC
Carbohydrates and Fats				
Non Fiber Carbohydrate	NFC	% of DM	40.83	C
Fat		% of DM	4.54	WC

Energy Calculations:NRC,2001			**** Verified ****	
Total Digestible Nutrients,1X	TDN	% of DM	74.20	C
Net Energy , Lactation, 3X	Nel	Mcals/lb	0.76	C
Net Energy , Maintenance	NEm	Mcals/lb	0.85	C
Net Energy , Gain	NEg	Mcals/lb	0.56	C
Metabolizable Energy	ME	Mcals/lb	1.27	C

Macro Minerals				
Phosphorus	P	0.44	% of DM	WC
Calcium	Ca	0.91	% of DM	WC
Potassium	K		% of DM	NIR
Magnesium	Mg		% of DM	NIR
Sodium	Na		% of DM	NR
Chloride	Cl		% of DM	NR
Sulfur	S		% of DM	NR

Micro Minerals				
Iron	Fe		ppm	NR
Manganese	Mn		ppm	NR
Zinc	Zn		ppm	NR
Copper	Cu		ppm	NR
Ash		7.54	%of DM	WC