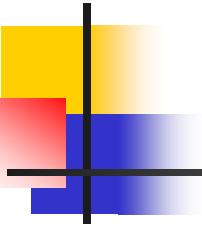# Why do lab analysis results vary, and what should we do about it?
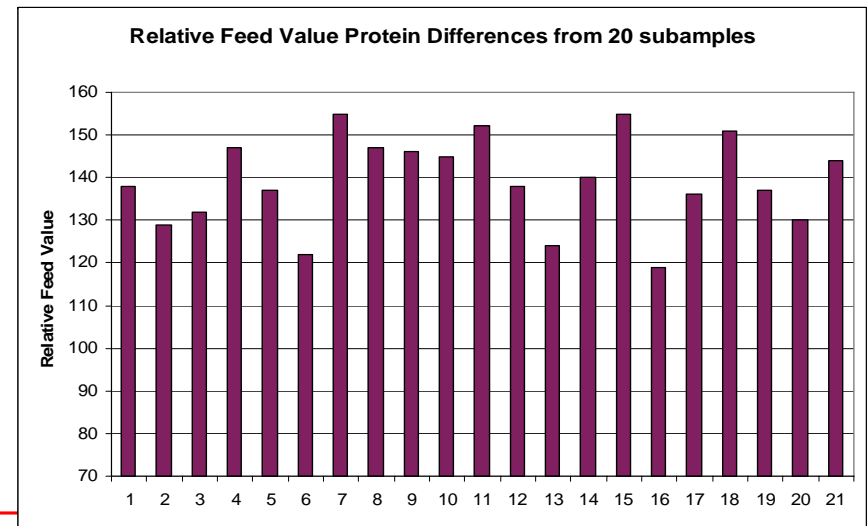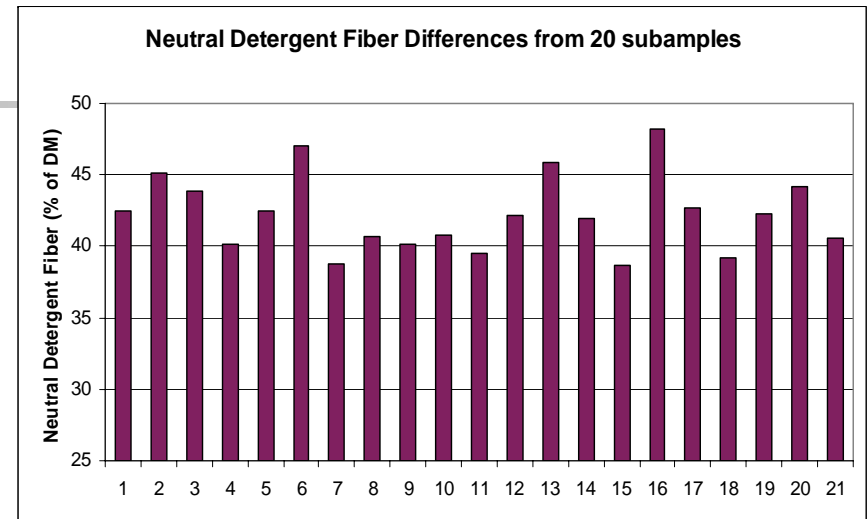
Dan Undersander
University of Wisconsin
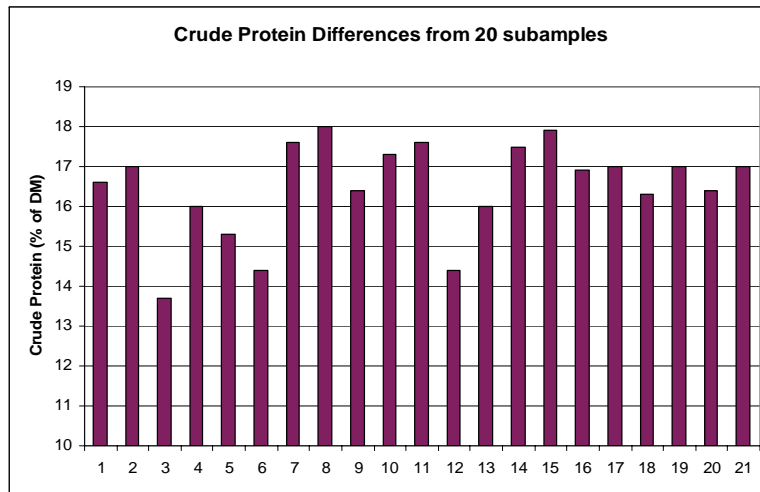
Why do Results Vary Among Laboratories?

- Sampling error by grower

- Subsampling error by laboratory

- Error of analysis

Sampling Variation Among hay bales

Crude Protein Differences from 20 subamples

Neutral Detergent Fiber Differences from 20 subamples

Relative Feed Value Protein Differences from 20 subamples

Variation in 20 different bales
from the same load

UWEX

Forage variability
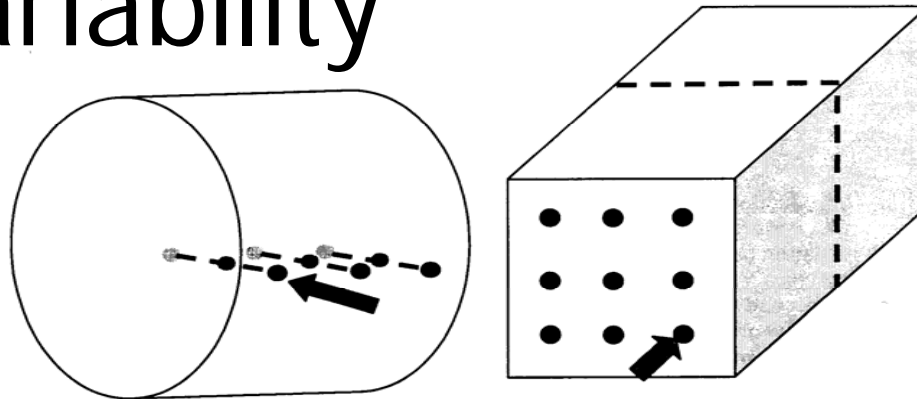
Figure 1. Sampling patterns of round and rectangular bales.

Variability of alfalfa hay bales

constituent	AVG	SD btwn bales	Min - max Btwn bales	SD Wthn bales
NDF	40.2	2.0	36.3 – 44.1	2.1
CP	17.2	0.8	15.7 – 18.7	0.8

UWEX

Collins, 2000

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Haylage NDF – Sampling and Laboratory Consistency Evaluation

43.3
44.4
45.7

40.7
41.0
41.8

36.0
36.3
37.8

43.3
43.6
43.7

41.6
42.9
43.0

36.4
37.7
37.9
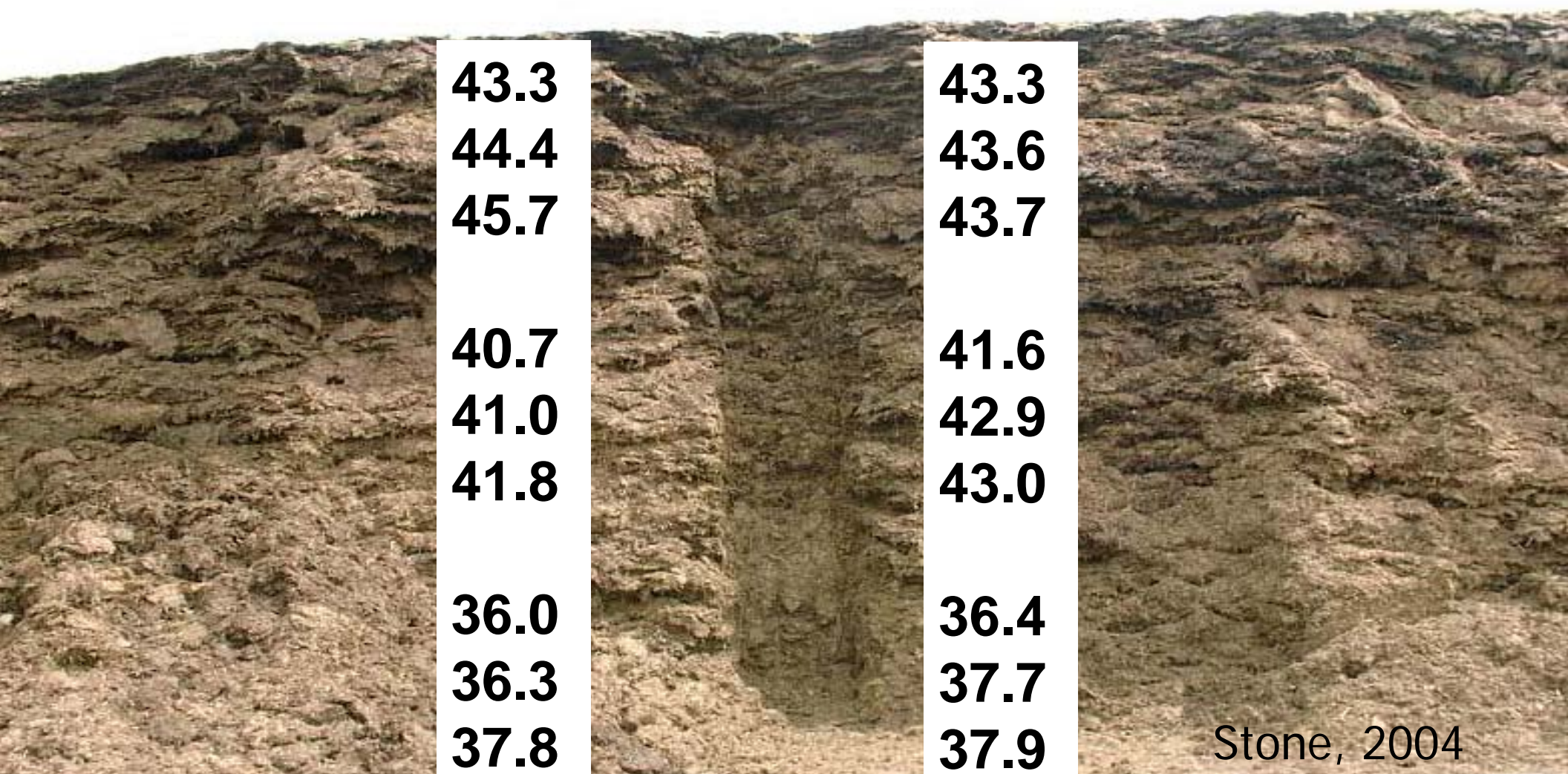
Stone, 2004

Sample Accurately
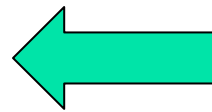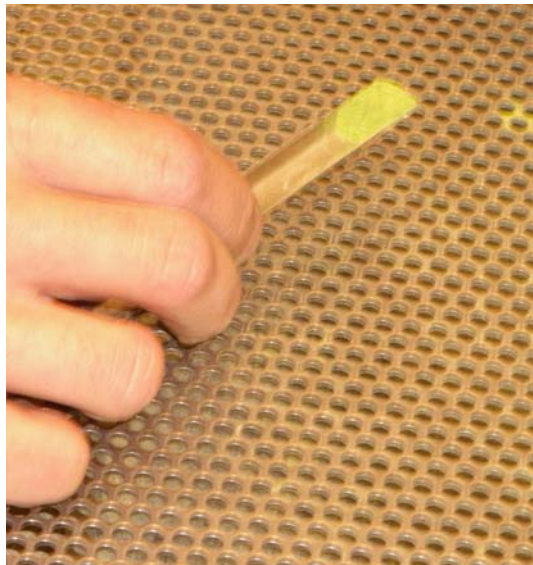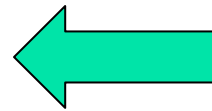
Why do Results Vary Among Laboratories?

- Sampling error by grower

- Subsampling error by laboratory

- Error of analysis

Subsampling Error by Laboratory

- **If greater than half pound sample is received**
  - Most are subsampled before drying
  - Subsample may not represent what was sent in

Subsampling Error by Laboratory

- If greater than half pound sample is received
    - Most are subsampled before drying
    - Subsample may not represent what was sent in
- Submitter can reduce this error by sampling well and submitting small sample

Why do Results Vary Among Laboratories?

- Sampling error by grower

- Subsampling error by laboratory

- Error of analysis

Error of Analysis

- Does analysis adequately estimate animal performance?

- Is laboratory accurately performing analysis?

Relationship of ADF to Summative TDN, Worlds Forage Superbowl, 2006

$y = -0.72x + 86.5$

$R^2 = 0.73$

Acid Detergent Fiber (ADF)

Summative TDN
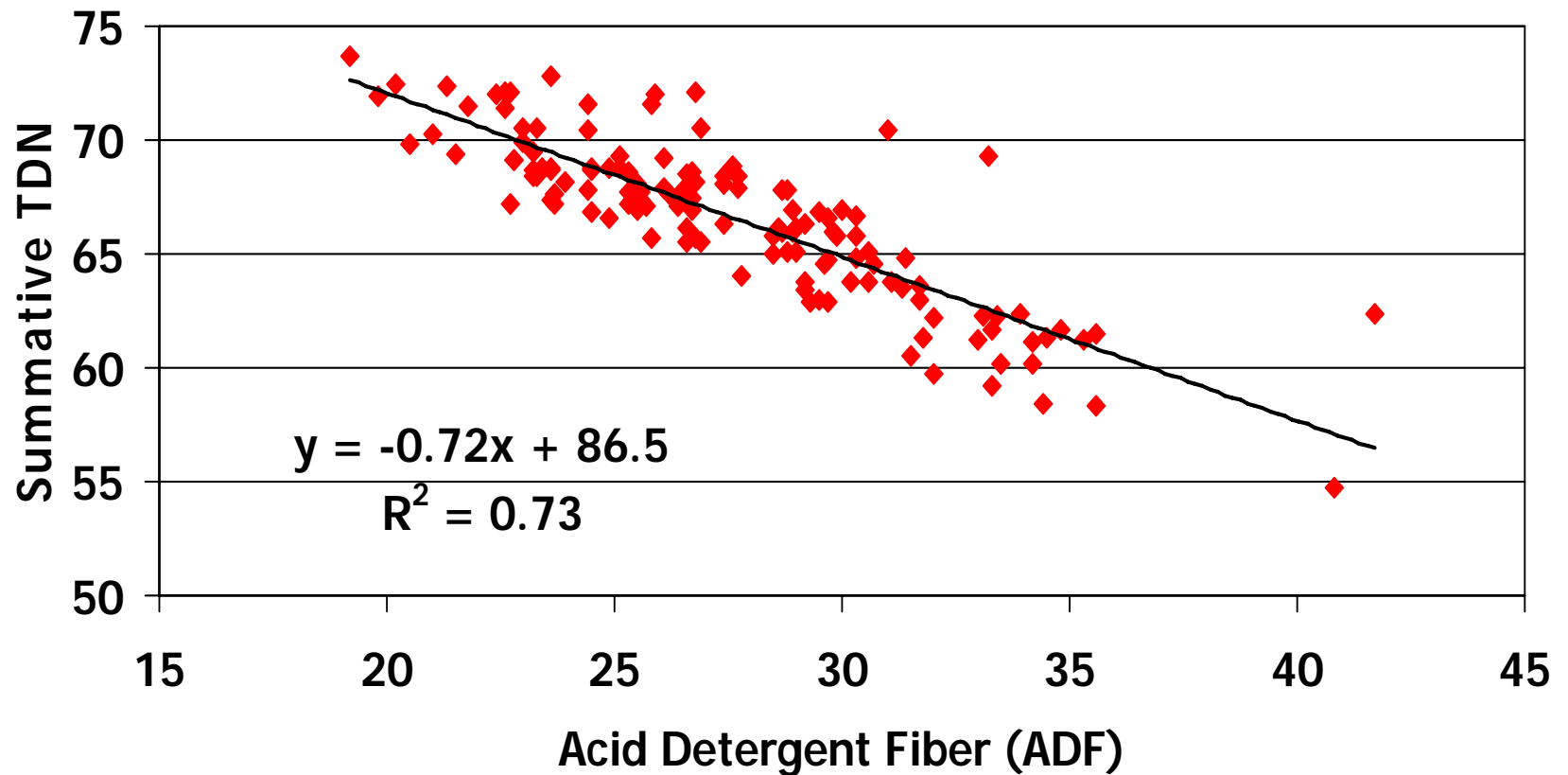
Relationship of ADF to Fiber Digestibility, Worlds Forage Superbowl, 2006
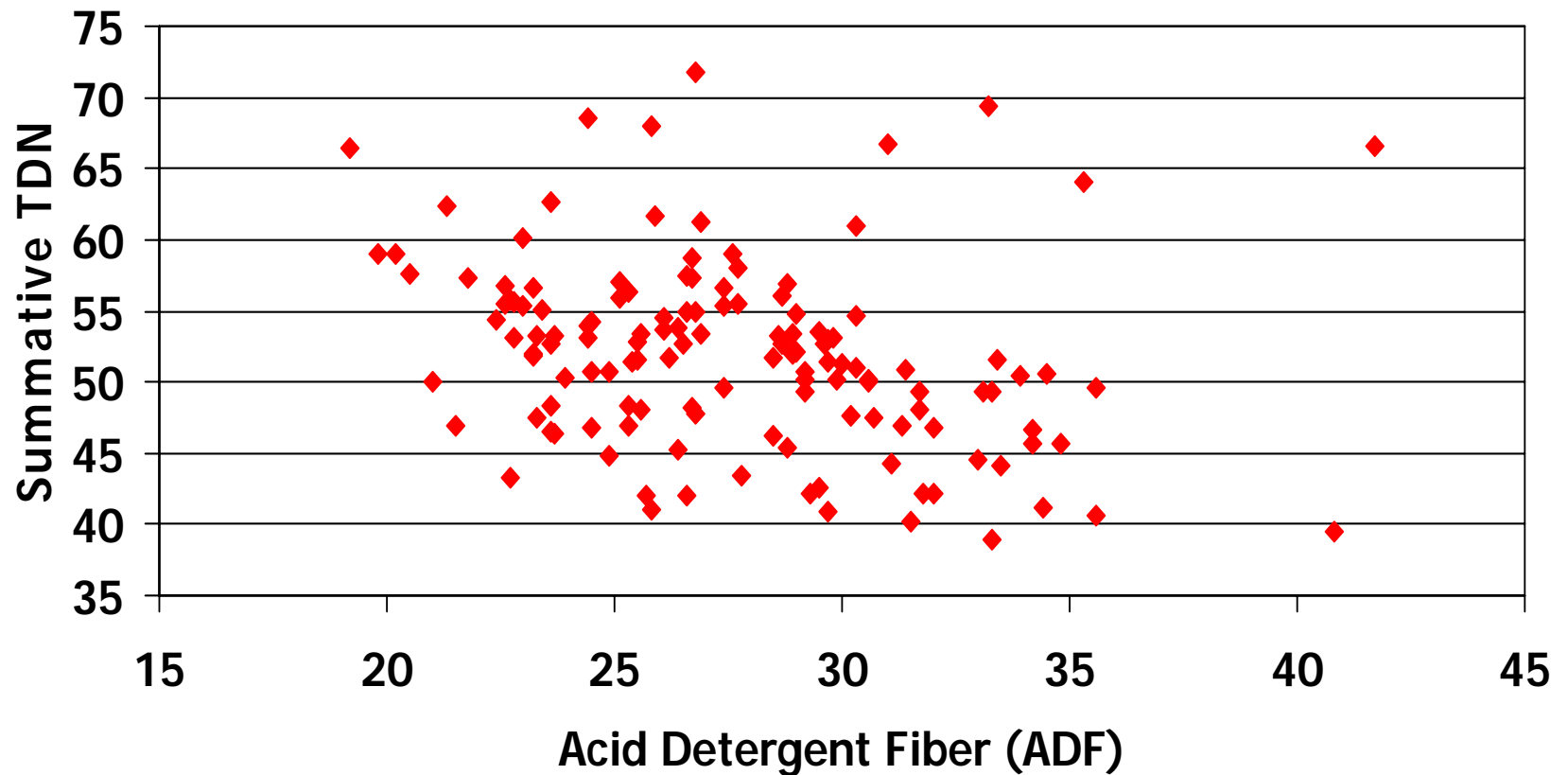
UWEX

Accuracy of Laboratories

- Does laboratory run entire or subsample?
- What is measured vs calculated?

```
                                      --------------------- ---- ---- --------
                                     |Sample Description   |Farm|Code| Sample |
                                     |MMG HAY              |    |102 |11337790|
                                     |--------------------- ---- ---- --------|
                                     |                                        |
                                     |----------------------------------------|
 -------- -------- -------- -- --    |            Analysis Results            |
|Sampled | Recvd  |Printed |ST|CO|  |--------------------- -------- --------|
|        |07/30/07|07/30/07|  |  |  |     Components       | As Fed |   DM   |
 -------- -------- -------- -- --    |--------------------- -------- --------|
     MIXED MOSTLY GRASS 204          |% Moisture           |   8.3  |        |
DART HAY SERVICE                     |% Dry Matter         |  91.7  |        |
2075 E ILLINOIS RT 18                |% Crude Protein      |  17.7  |  19.3  |
STREATOR, IL 61364                   |% Available Protein  |  16.5  |  18.0  |
                                     |% ADICP              |   1.2  |   1.3  |
                                     |% Adjusted Crude Protein| 17.7|  19.3  |
--------------------------------     |Soluble Protein % CP |        |   46   |
     ENERGY TABLE - NRC 2001         |Degradable Protein %CP|       |   73   |
BW = 1350  Fat% = 3.7 Tprot% = 3.1   |% NDICP              |   3.1  |   3.4  |
--------------------------------     |% Acid Detergent Fiber|  28.8 |  31.4  |
Milk,      NEL      NEL     Milk,    |% Neutral Detergent Fiber| 40.2| 43.9  |
Lb       Mcal/Lb  Mcal/Kg    Kg      |% Lignin             |   6.3  |   6.9  |
--------  -------  -------   ----     |% NFC                |  25.4  |  27.7  |
Dry        0.64     1.41    Dry       |% Starch             |   1.0  |   1.0  |
40         0.61     1.34     18       |% WSC (Water Sol. Carbs.)| 9.4| 10.2  |
60         0.59     1.29     27       |% ESC (Simple Sugars)|   7.1  |   7.8  |
80         0.55     1.22     36       |% Crude Fat          |   2.2  |   2.5  |
100        0.52     1.15     45       |% Ash                |  9.27  |  10.11 |
120+       0.48     1.06     54+      |% TDN                |   54   |   59   |
--------------------------------     |NEL, Mcal/Lb         |   .55  |   .60  |
NEM3X      0.61     1.35              |NEM, Mcal/Lb         |   .50  |   .55  |
NEG3X      0.35     0.78              |NEG, Mcal/Lb         |   .27  |   .29  |
ME1X       1.03     2.28              |Relative Feed Value  |        |  137   |
DE1X       1.23     2.70              |% Calcium            |  1.19  |  1.30  |
TDN1X,%      59                       |% Phosphorus         |   .21  |   .23  |
--------------------------------     |% Magnesium          |   .22  |   .24  |
                                     |% Potassium          |  2.37  |  2.59  |
COMMENTS:                            |% Sulfur             |   .25  |   .27  |
                                     |% Chloride Ion       |  1.06  |  1.16  |
 1.NRC ENERGIES - SMALL BREEDS -     |Horse TDN, %         |   52   |   57   |
   DO NOT USE ENERGIES BEYOND 80     |Horse DE, Mcal/lb    |  1.04  |  1.13  |
   LBS. MILK.  LARGE BREEDS - USE    |                     |        |        |
```

UWEX

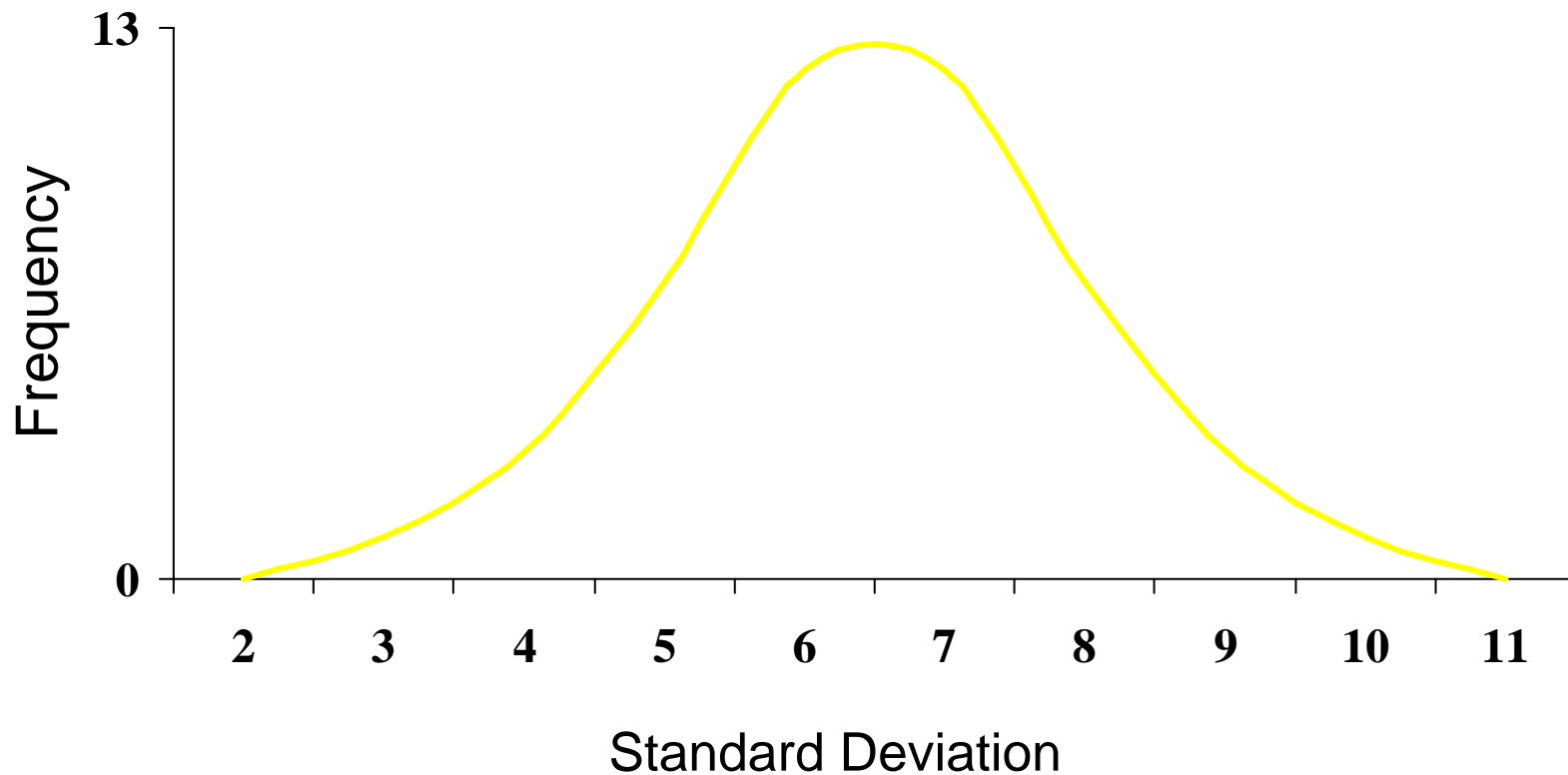*Dan Undersander-Agronomy © 2007*

Accuracy of Laboratories

- Does laboratory run entire or subsample?
- What is measured vs calculated?
- Does laboratory use standard or modified procedures?
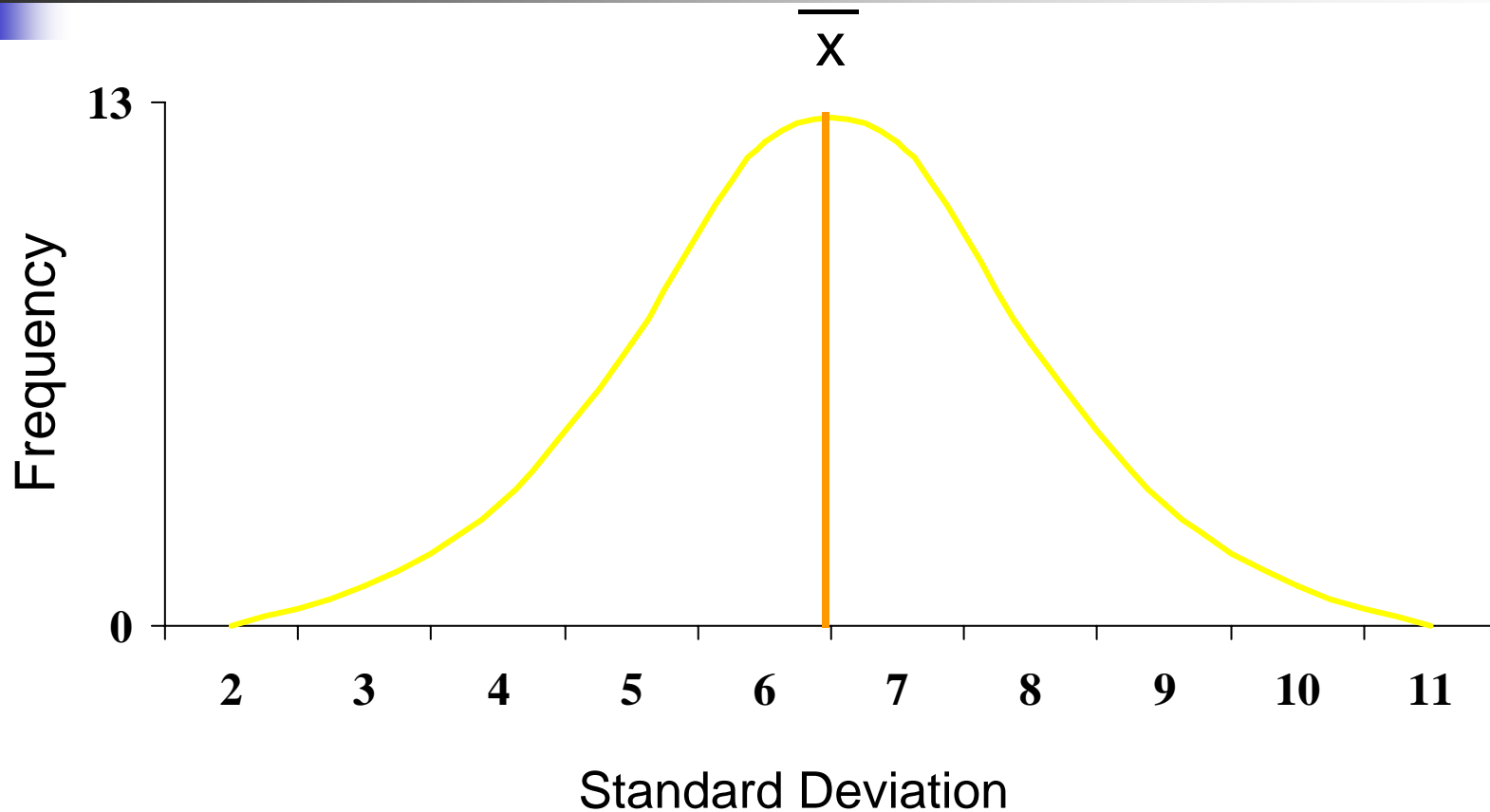- Is laboratory certified?
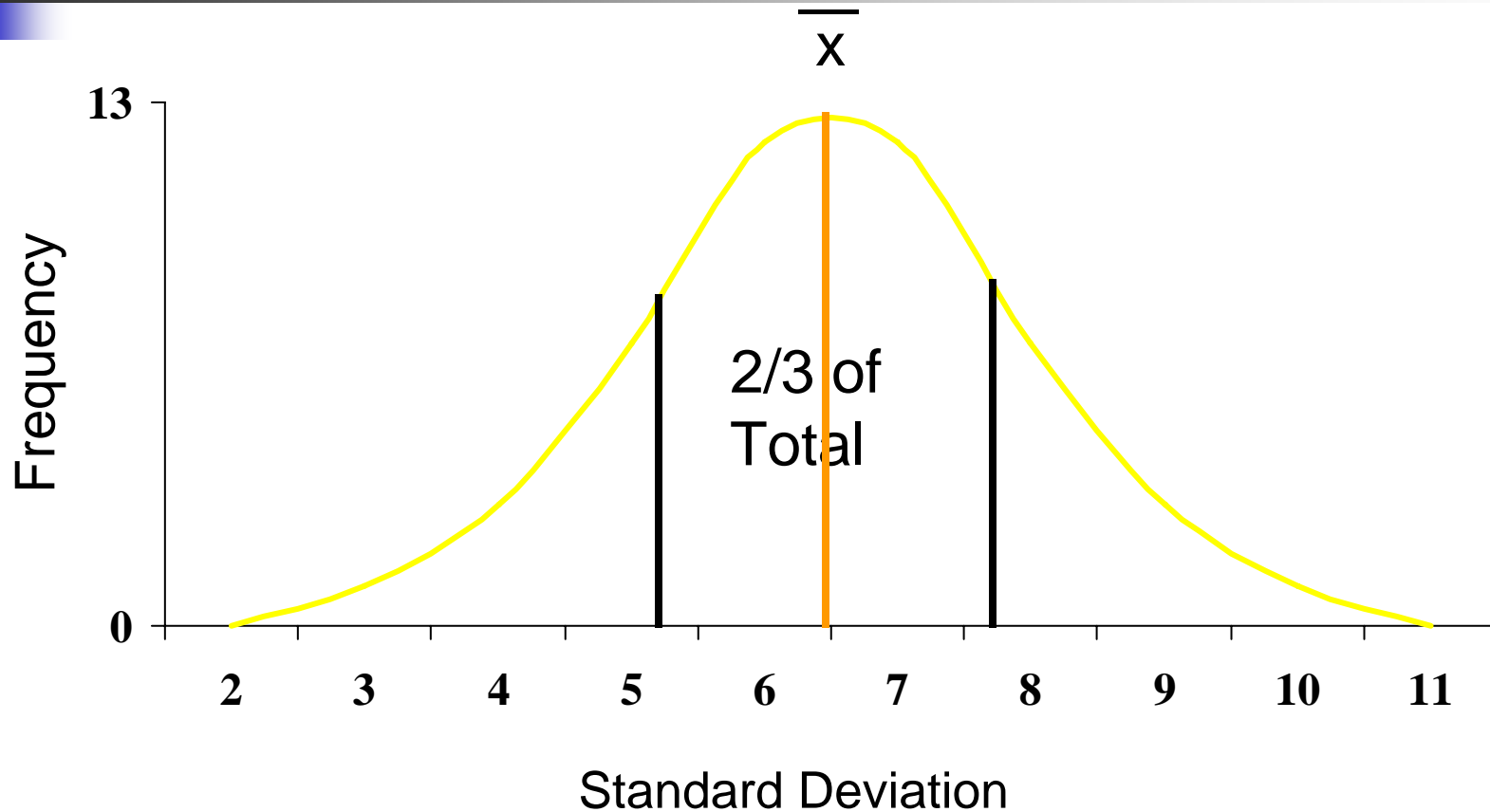
Error of Analysis
Standard Deviation

Error of Analysis
Standard Deviation

Error of Analysis
Standard Deviation

$\overline{x}$

2/3 of Total

Frequency

Standard Deviation

Performance of forage testing laboratories participating in National Forage Testing Association check sample program, 2004.

Parameter	Crude protein	ADF	NDF
For laboratories running recommended reference methods			
Count	22	10	11
Average	15.2	28.5	39.1
Standard Deviation	0.2	0.5	0.6

UWEX

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Performance of forage testing laboratories participating in NFTA check sample program, 2004.

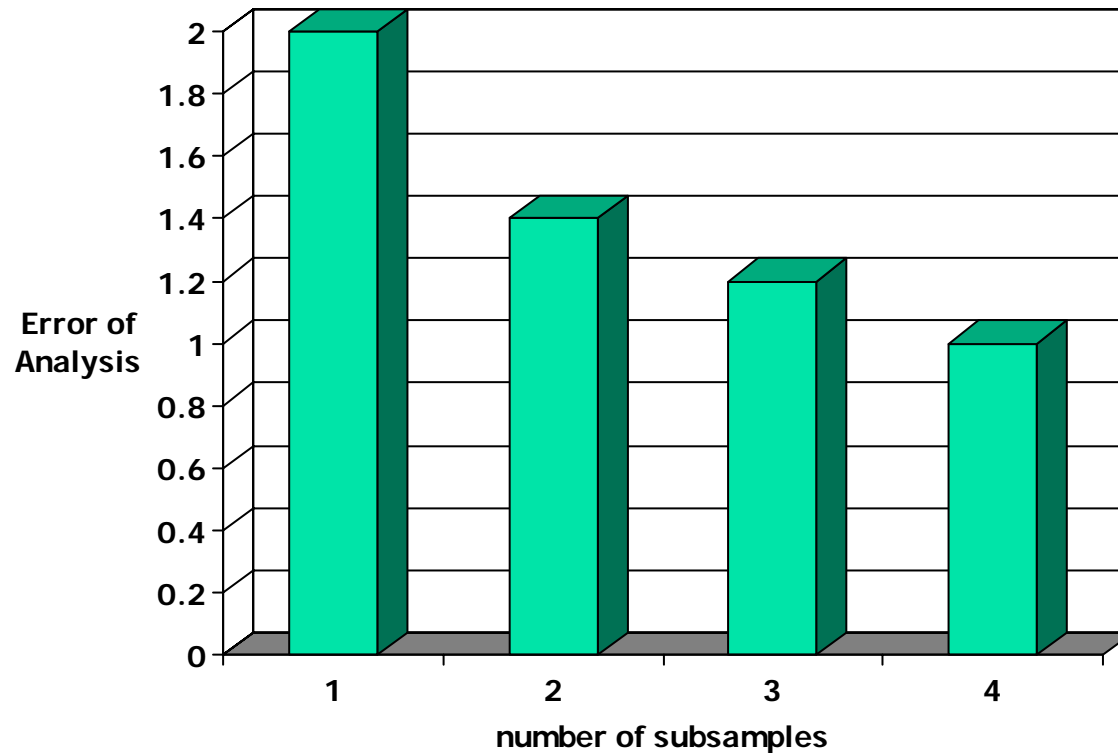| Parameter	Crude protein	ADF	NDF
For laboratories running recommended reference methods			
Count	22	10	11
Average	15.2	28.5	39.1
Standard Deviation	0.2	0.5	0.6
For all laboratories			
Count	135	136	135
Average	15.3	28.4	39.8
Standard Deviation	0.8	1.4	2.3

UWEX

A Method to Reduce Analysis Error

- Analyze multiple samples

Reducing final error with multiple samples

Multiple sample analysis reduces error

Submit 3 subsamples

Dealer: Rock River Laboratory, Inc.
710 Commerce Drive
Watertown, WI 53094

Feeder: XXXXXXXXXXX

Sample ID: 3rd Cutting Alfalfa Hay Stack

Sample Date 1/30/2007
Report Date 2/5/2007

	Average	Standard Deviation	min	max
Moisture	11.38	0.585	10.73	11.86
Crude Protein	22.43	1.394	20.83	23.40
Acid Det. Fiber %DM	29.27	1.096	28.03	30.12
Netural Det. Fiber %DM	37.60	1.566	36.07	39.20
NDF Dig. as % of NDF-48HR	47.78	1.772	46.10	49.63
N.F.C.	29.96	0.821	29.05	30.65
Calcium %DM	1.57	0.046	1.52	1.60
Phosphorus %DM	0.27	0.032	0.23	0.29
Magnesium %DM	0.30	0.030	0.27	0.33
Potassium %DM	3.06	0.235	2.80	3.25

- Standard Deviation – 2/3 of time a fourth subsample will be with this range

UWEX

Benefits of Replicated Analysis

- Give user results with less variability

- Give user results with an estimate of variability

  - To indicate accuracy of forage sampling

  - To indicate variability of lot.

  - To allow both buyer and seller understand that analysis results are estimates with a range – not absolute values.

Summary

- Take a good forage sample
  - Use a sample corer for hay
  - Multiple bales
  - Don't send over half pound sample
- Some laboratories vary in their results
  - Check for NFTA certification
    - www.foragetesting.org
- Consider multiple samples