Getting More from Forages

## Targeted feeding strategies:

### Accounting for variability

# Adjusting for forage variability via on-farm analysis

David Mertens
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# Introduction

- Forage composition has large variability, within the lot (Collins, 2000; Stone et al., 2003) and over time (Undersander et al., 2005);
- Variability in forages is unavoidable, but can be managed using sampling protocols (St. Pierre and Cobanov, 2007) and adequate analytical tools (Near infrared)

# Forage variability: hay

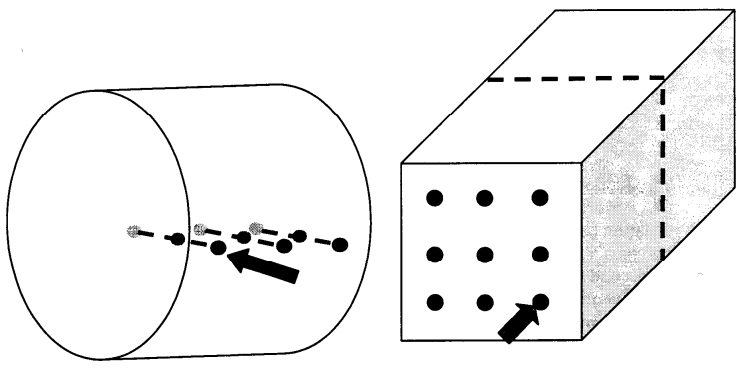


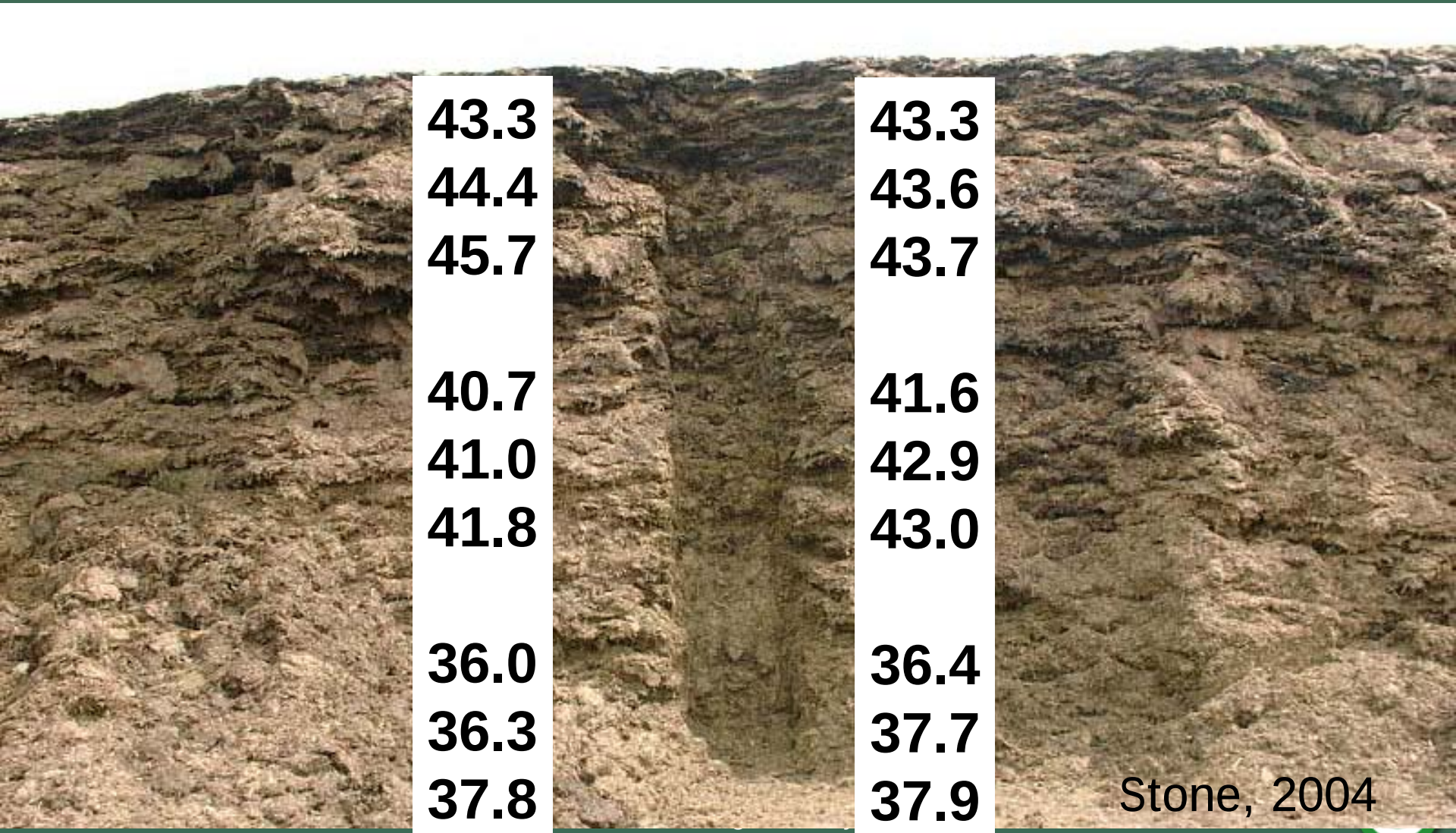
**Figure 1.** Sampling patterns of round and rectangular bales.

| Constituent | AVG | SD Btwn bales | Min - max Btwn bales | SD W/in bales |
|---|---|---|---|---|
| NDF | 40.2 | 2.0 | 36.3 – 44.1 | 2.1 |
| CP | 17.2 | 0.8 | 15.7 – 18.7 | 0.8 |



Collins, 2000

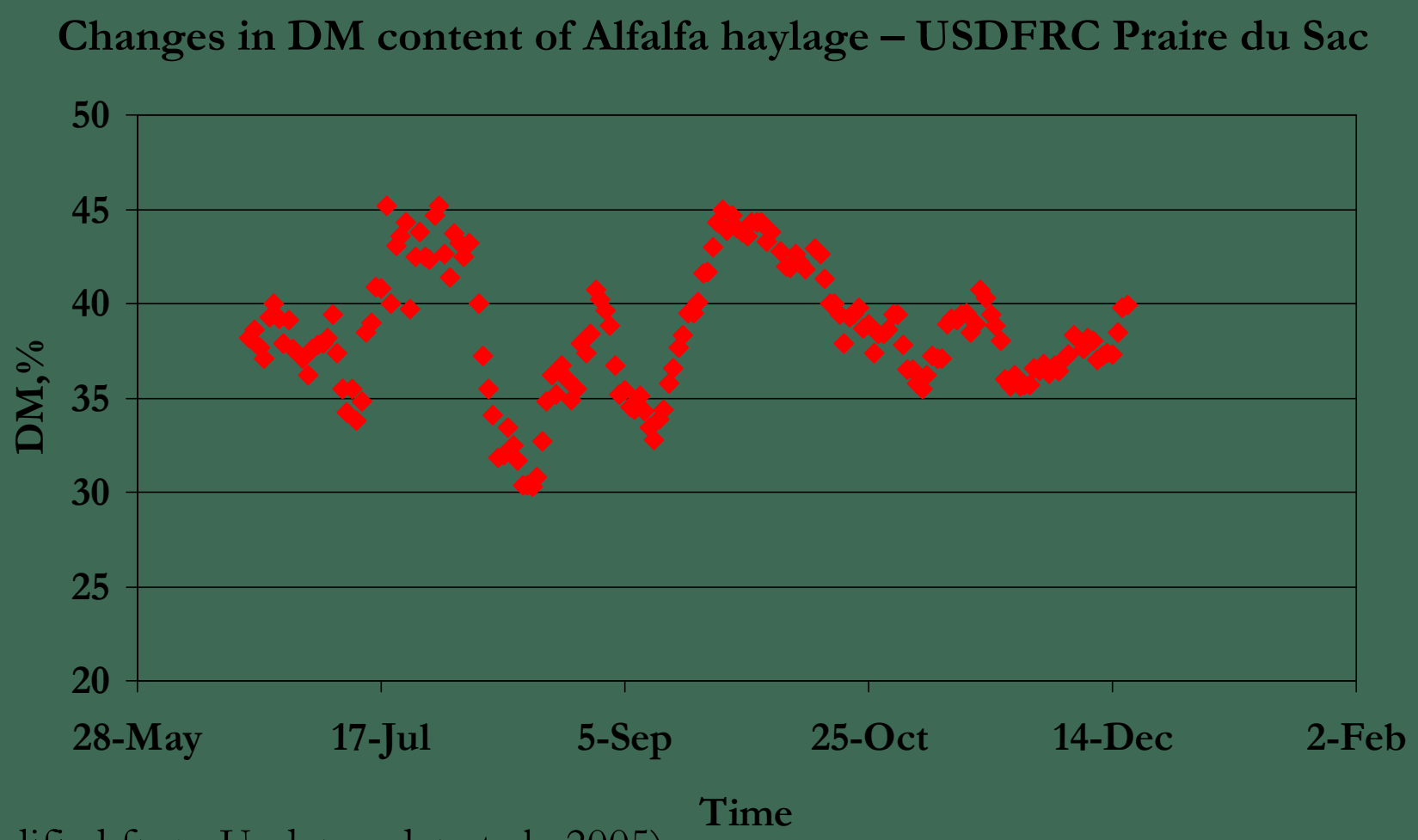
# Haylage NDF – Sampling and Laboratory Consistency Evaluation



| | |
|---|---|
| 43.3 | 43.3 |
| 44.4 | 43.6 |
| 45.7 | 43.7 |
| | |
| 40.7 | 41.6 |
| 41.0 | 42.9 |
| 41.8 | 43.0 |
| | |
| 36.0 | 36.4 |
| 36.3 | 37.7 |
| 37.8 | 37.9 |

Stone, 2004

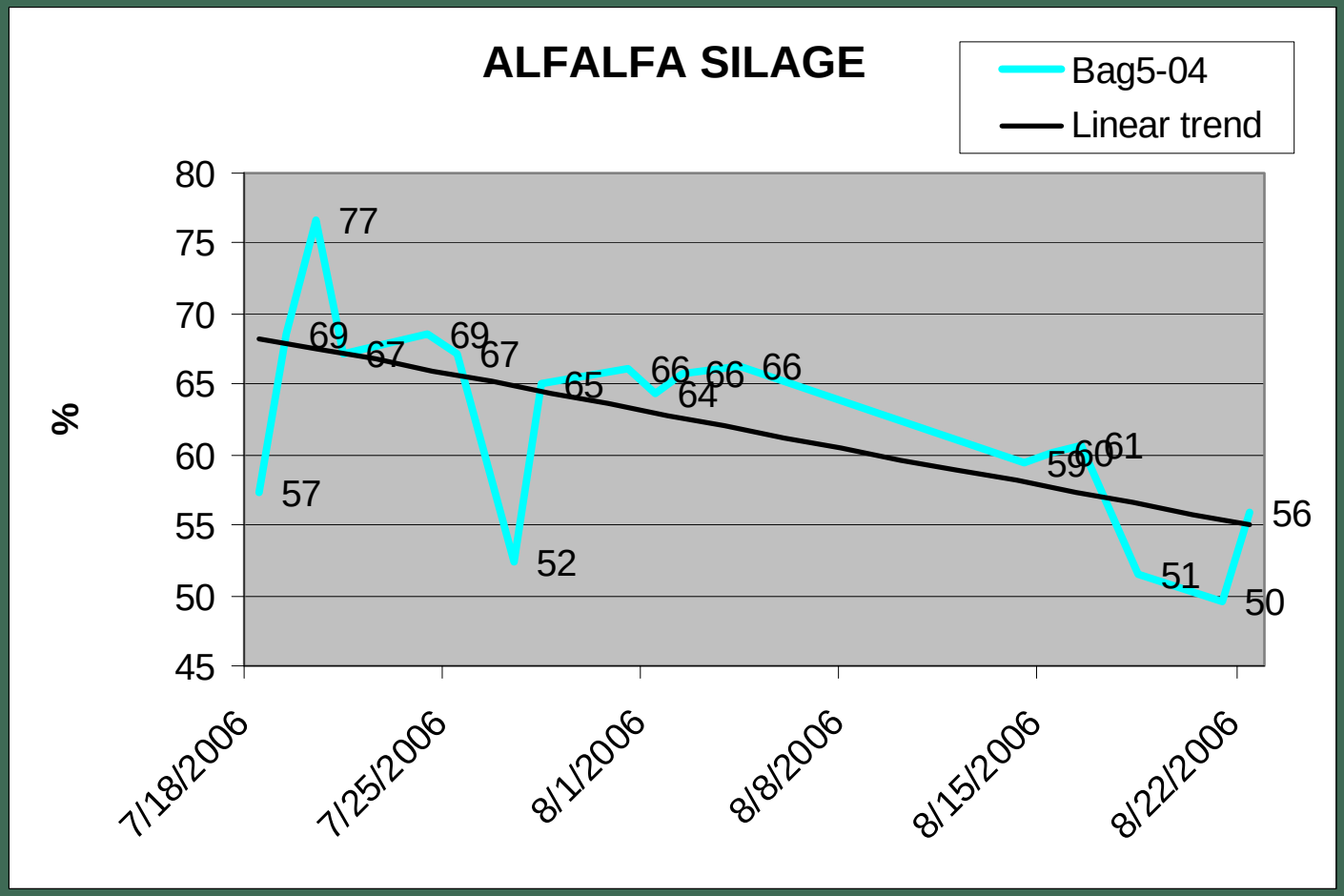
# Variation in forages over time




(modified from Undersander et al., 2005)

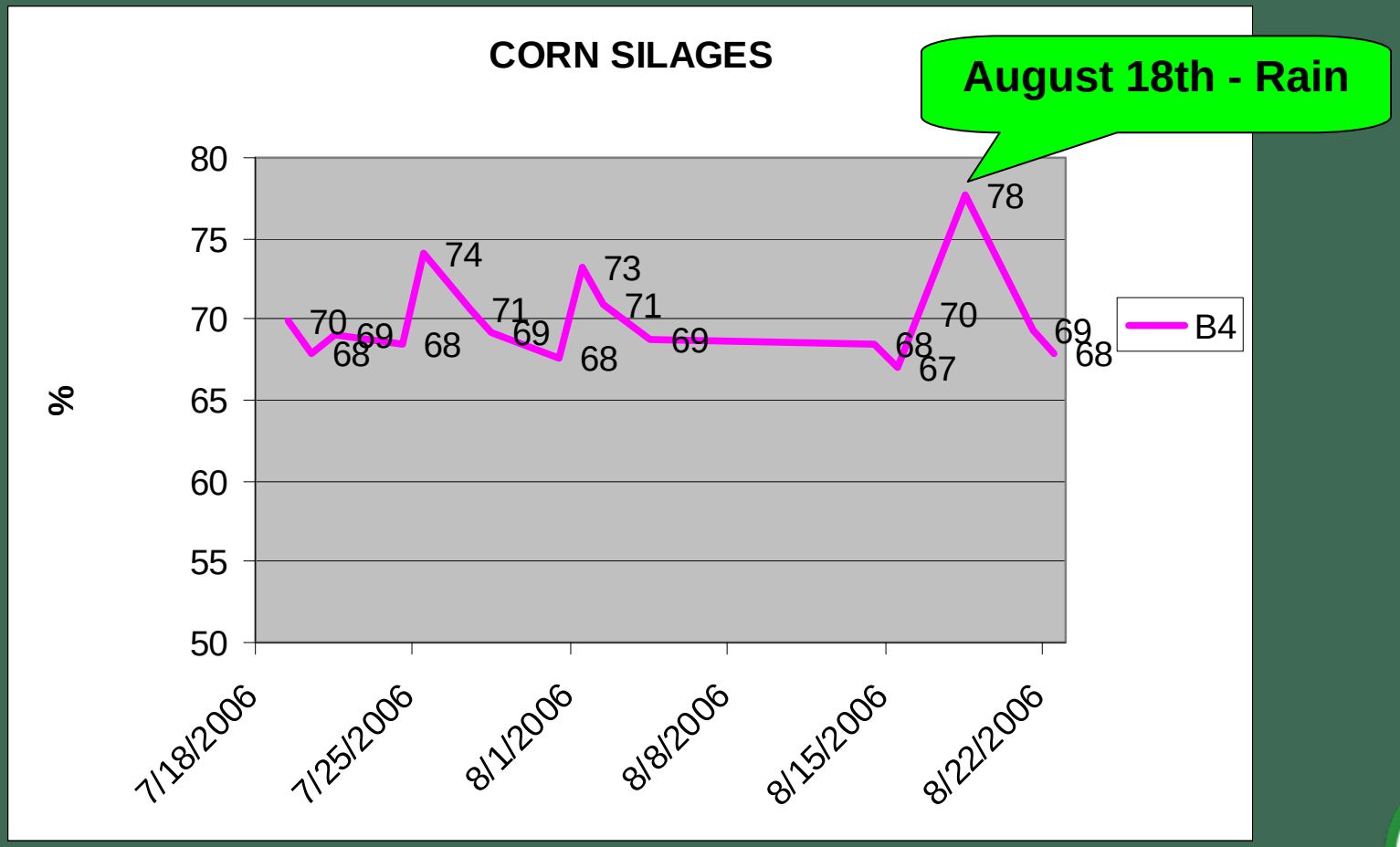
# Variation in forages over time

**Changes in Moisture content of Alfalfa silage – USDFRC Praire du Sac July 18-August 22 2006**



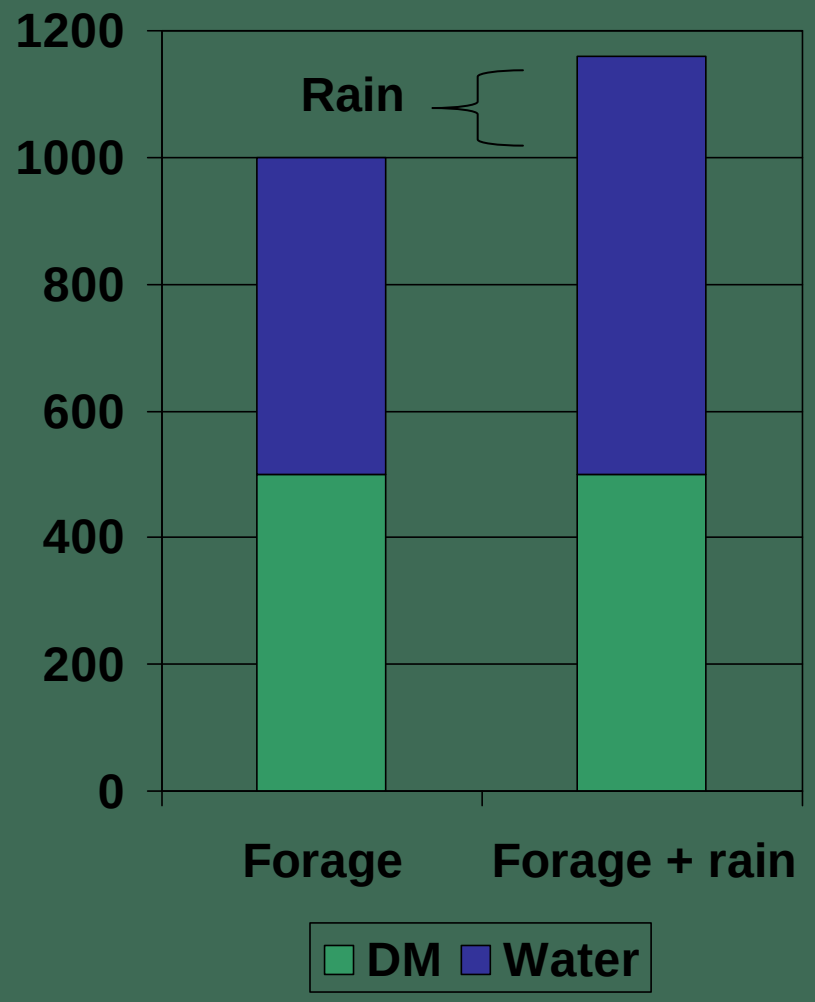
# Variation in forages over time

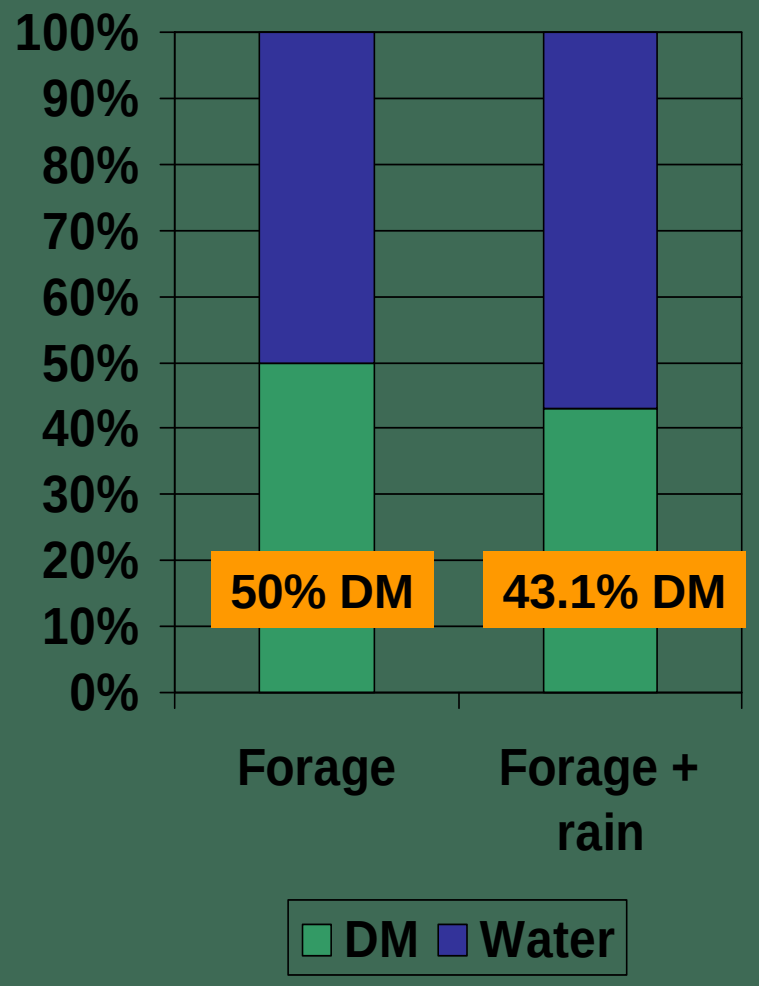
Changes in Moisture content of Corn silages – USDFRC Praire du Sac July 18-August 22 2006



# Effect of rain (20mm) on a 50% DM Forage

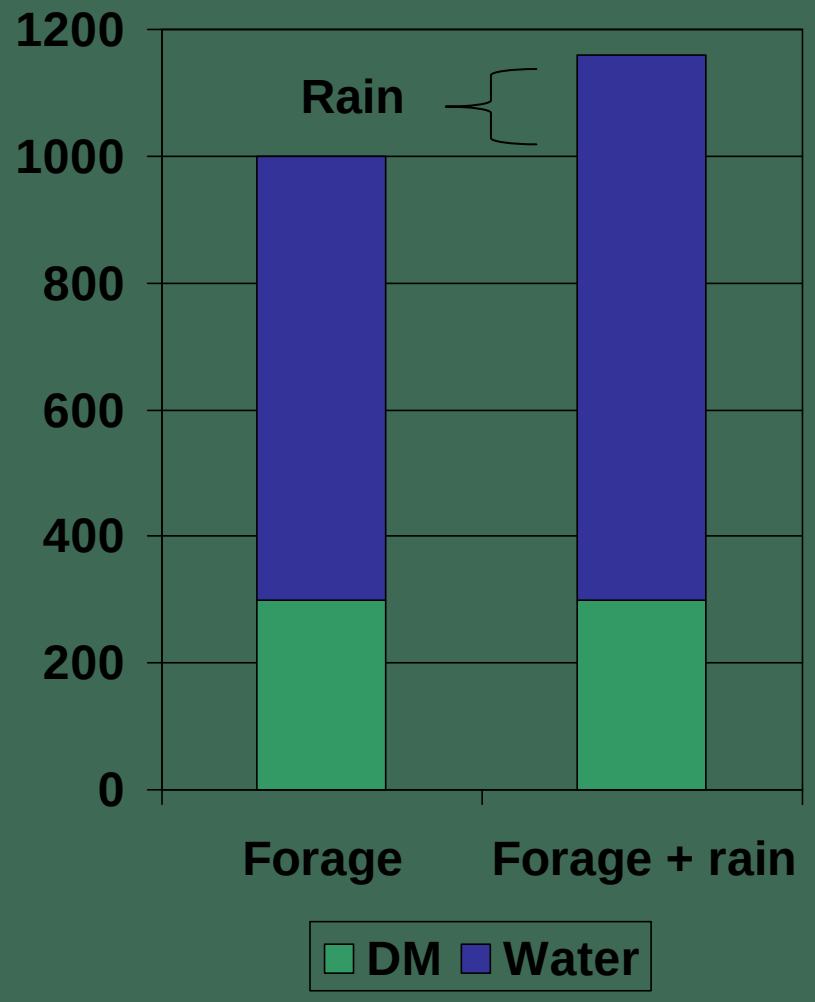
**In 2008 in Dane county there were 27 rain events averaging about 20mm of rain**

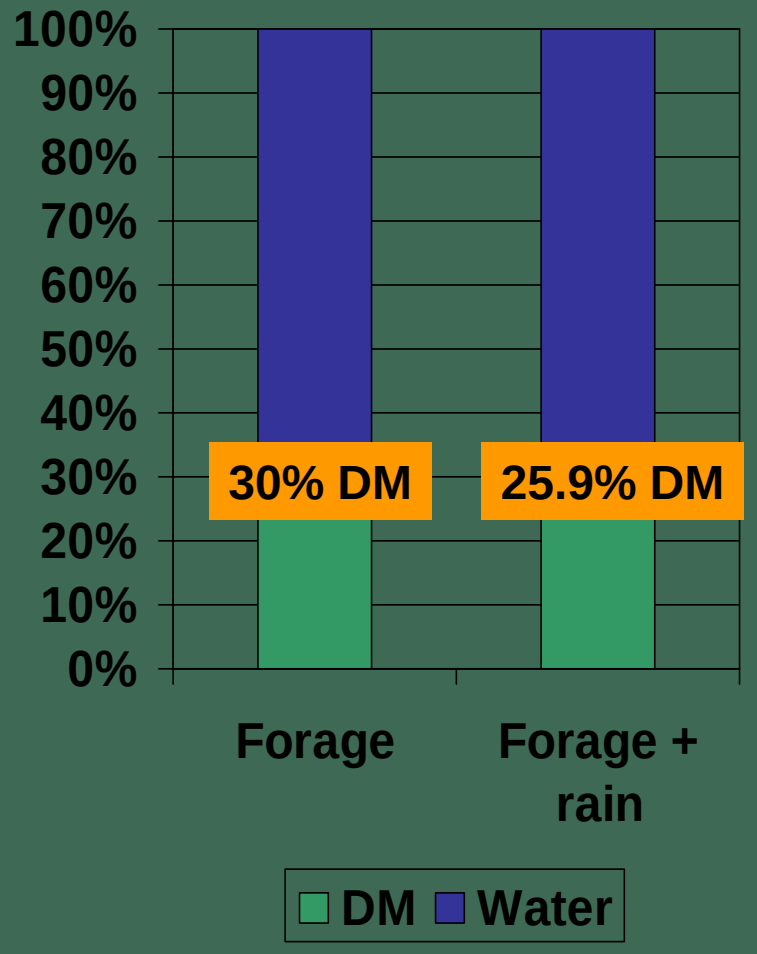


# Effect of rain (20mm) on a 30% DM Forage

**In 2008 in Dane county there were 27 rain events averaging about 20mm of rain**



# Effects of forage DM changes

| Feed | *kg/d* |
|---|---|
| **Corn Silage** | **26.0** |
| **Grass hay** | **2.0** |
| **HMC** | **3.0** |
| **Ground Corn** | **2.0** |
| **Cotton seed** | **1.5** |
| **SBM** | **3.0** |
| **Extr. Soy** | **1.5** |
| **Prot-min-vit conc.** | **2.5** |
| **Water** | **2.0** |

| Chem. Comp | **CS DM** | |
|---|---|---|
| | **38%** | **32%** |
| As is, kg | **43.5** | **43.5** |
| DM, kg | **23.1** | **21.5** |
| DM, % | **53.1** | **49.5** |
| CP, % | **16.4** | **17.1** |
| NDF% | **30.9** | **29.9** |
| Starch,% | **26.4** | **26.0** |
| EE% | **4.9** | **5.1** |
| ASH% | **8.6** | **8.5** |
| [1]Milk. Kg/d | **40.5** | **38.5** |

**[1] Predicted by the Dairy NRC 2001**

# Effects of Feed Variability

**Animal performance**
**Animal health**
**Excretion of nutrients**
**Farm profitability**

**Managing feed variability:**
**is worth $0.27/cow/day**
**or about 1kg of milk/d**

(St-Pierre, 2006)

# Value of analysis: a farm experience

- **Frequent adjustments would result in an increase in productivity (value per 100 cows):**

  - **1095 $/yr with the determination of DM;**
  - **2190 $/yr with chem. analysis of forages;**
  - **1095 $/yr with complete analysis of concentrates;**

  - **TOTAL $4380 gained per year for 100 cows**

(Tylutki et al. 2002)

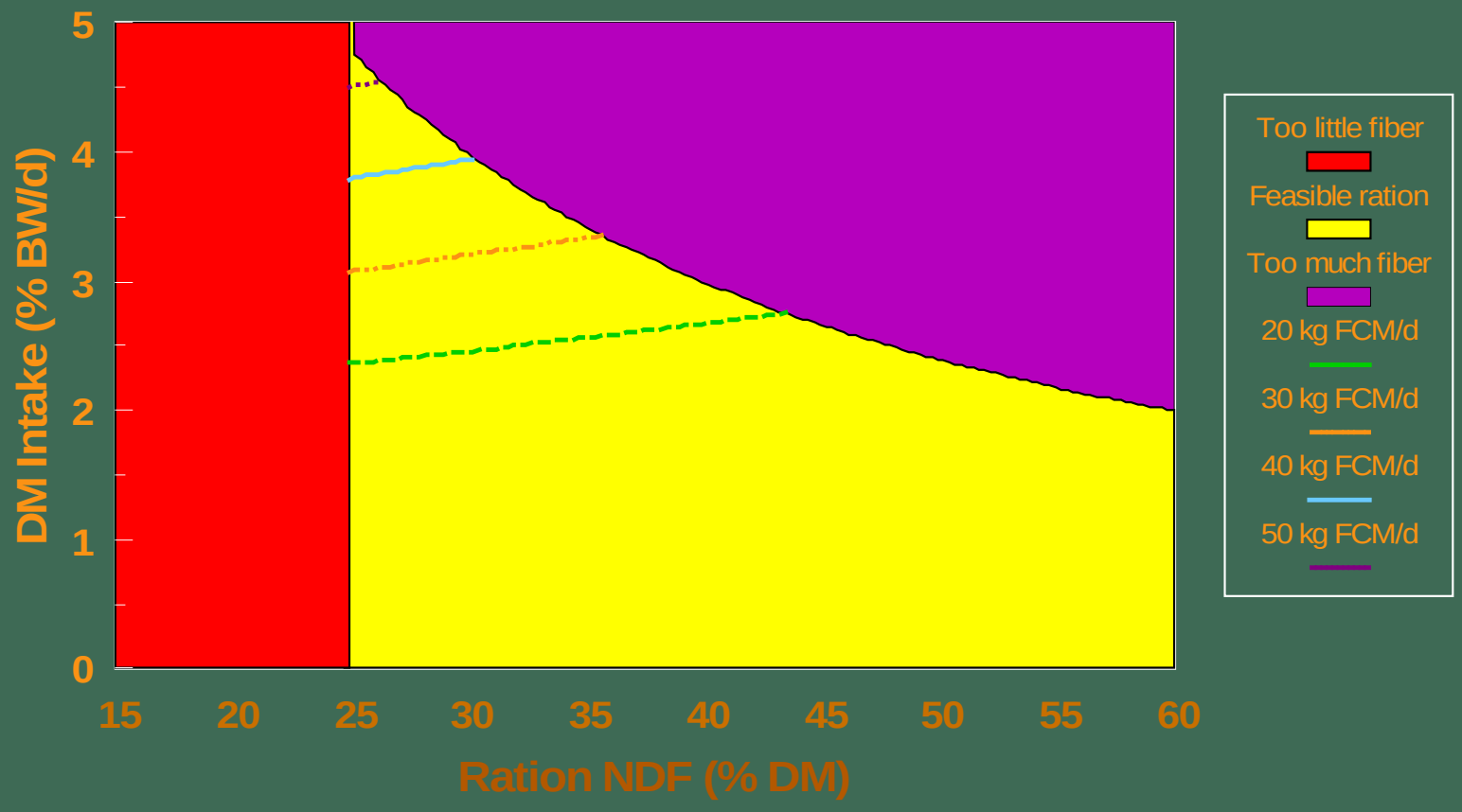
# Why do we need to feed cows precisely every day?

High producing cows are fed a very narrow range in diets

- The conflict between high nutrient demand and minimum fiber requirements means that dairy rations are finely tuned (balanced) to meet numerous nutrient requirements

# NDF-Energy Intake System

## Ration options decrease as milk production increases

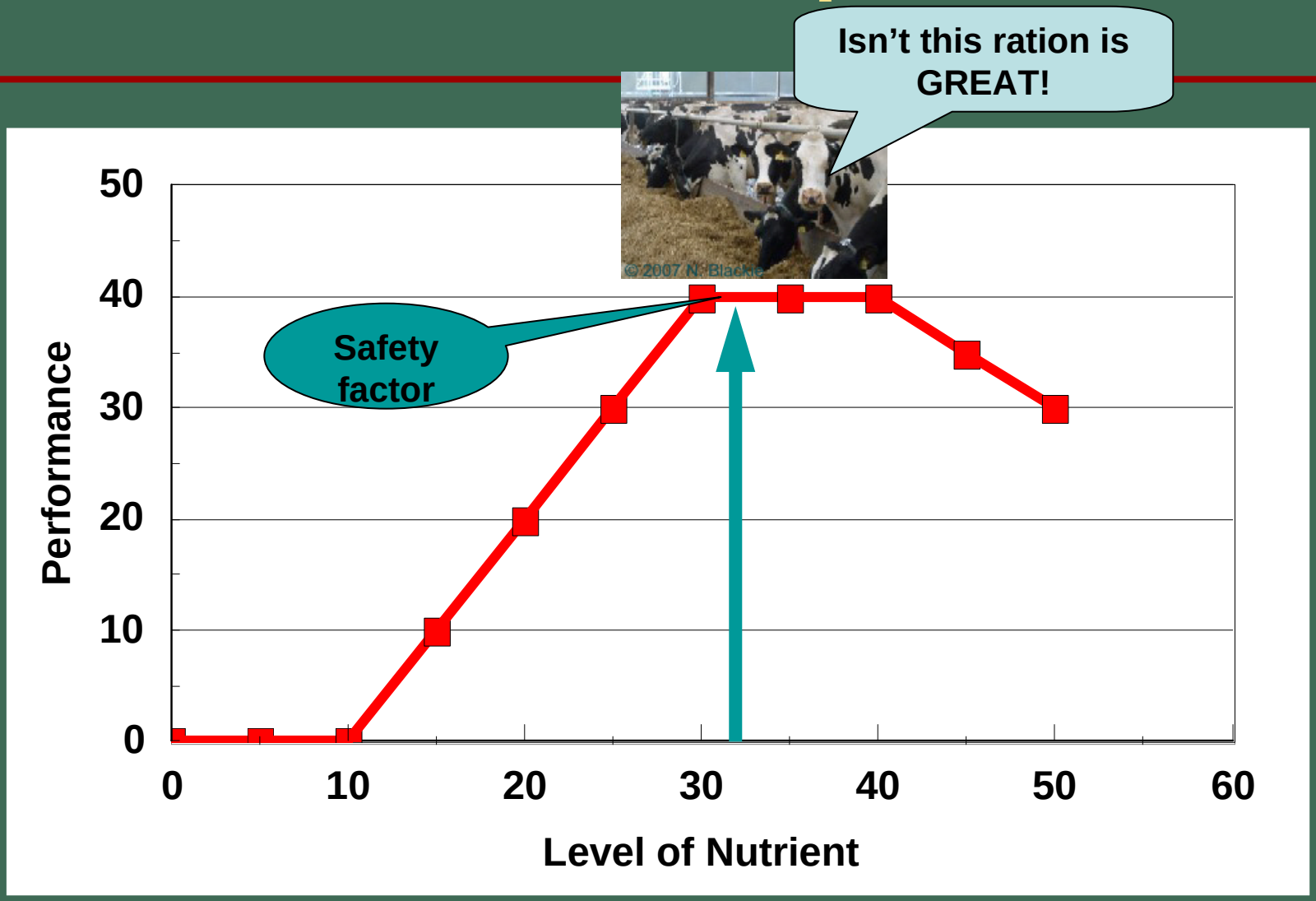


# Why do we need to feed cows precisely every day?

High producing cows are fed a very narrow range in diets

- Like a race car – everything is tuned for maximum power and traction – change anything (blown tire) and disaster happens!

# Classical Dose-Response

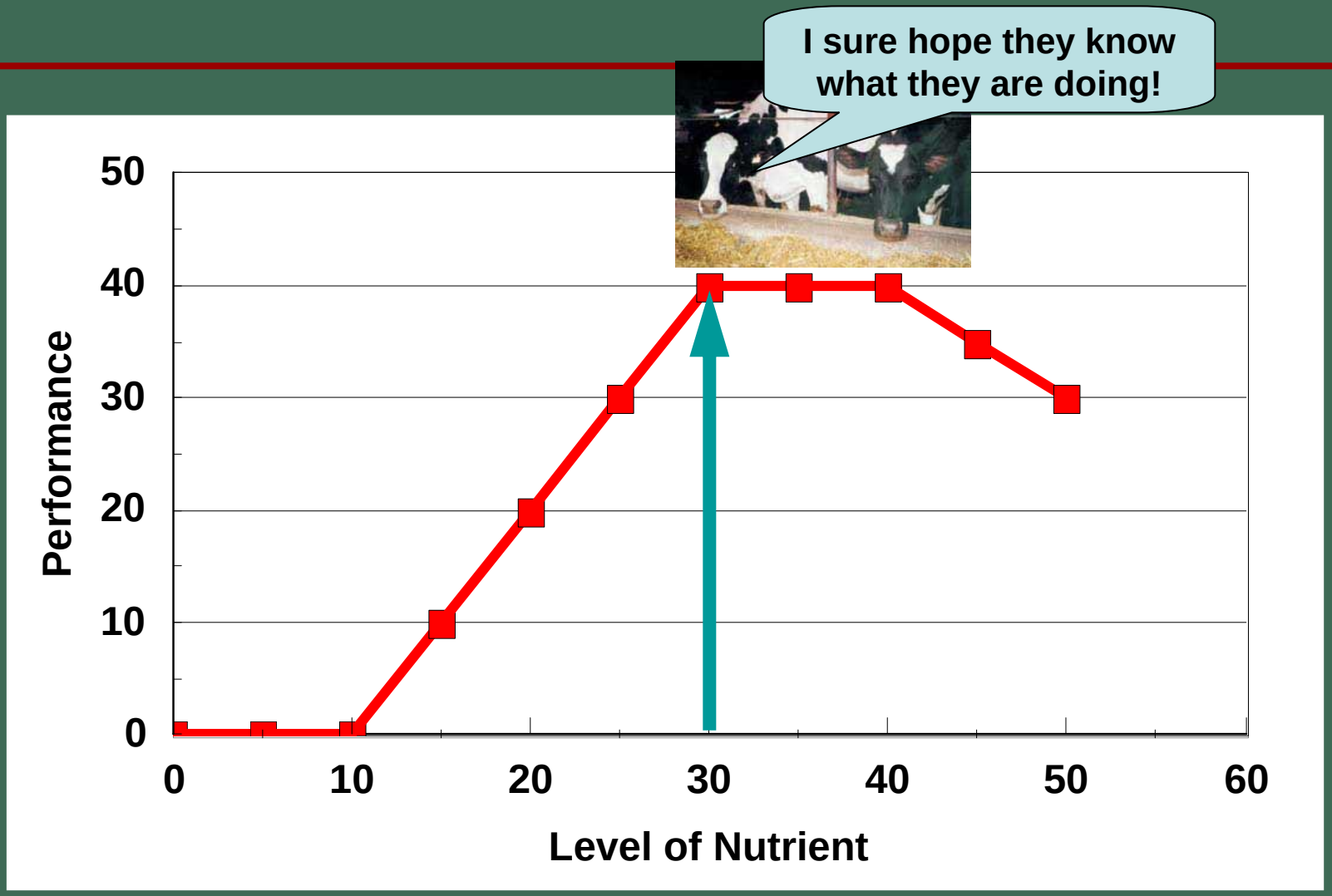


# Why do we need to feed cows precisely every day?

**Difficult to over-formulate rations like we did in the past**

- **Can't maintain balance of nutrients in rations for high production**
  - Putting in one nutrient in excess requires the removal of another required nutrient
- **Environmental concerns related to excessive nutrient excretion**

# Classical Dose-Response



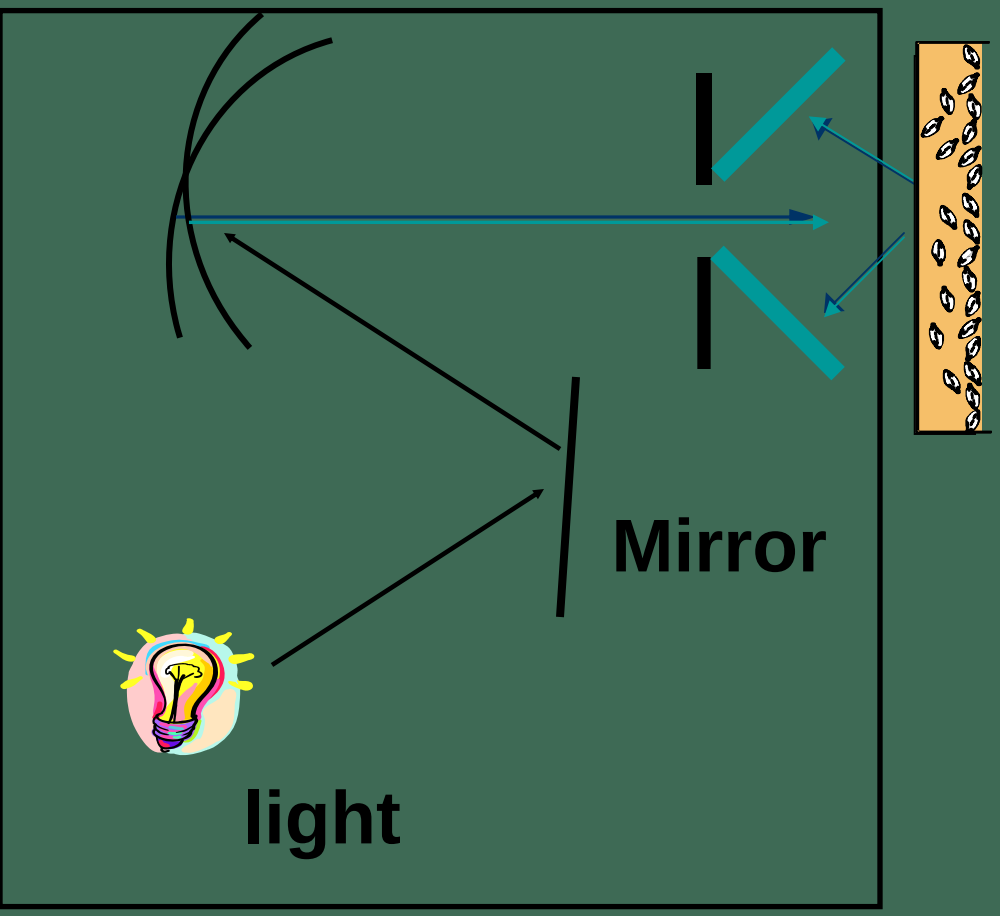
# Feed Quality Control Program

- **Requires**
  - **Frequent sampling**
  - **Rapid return of results**
  - **Accurate analytical method**
  - **Simple to implement**
  - **Low cost**

# NIRS Options

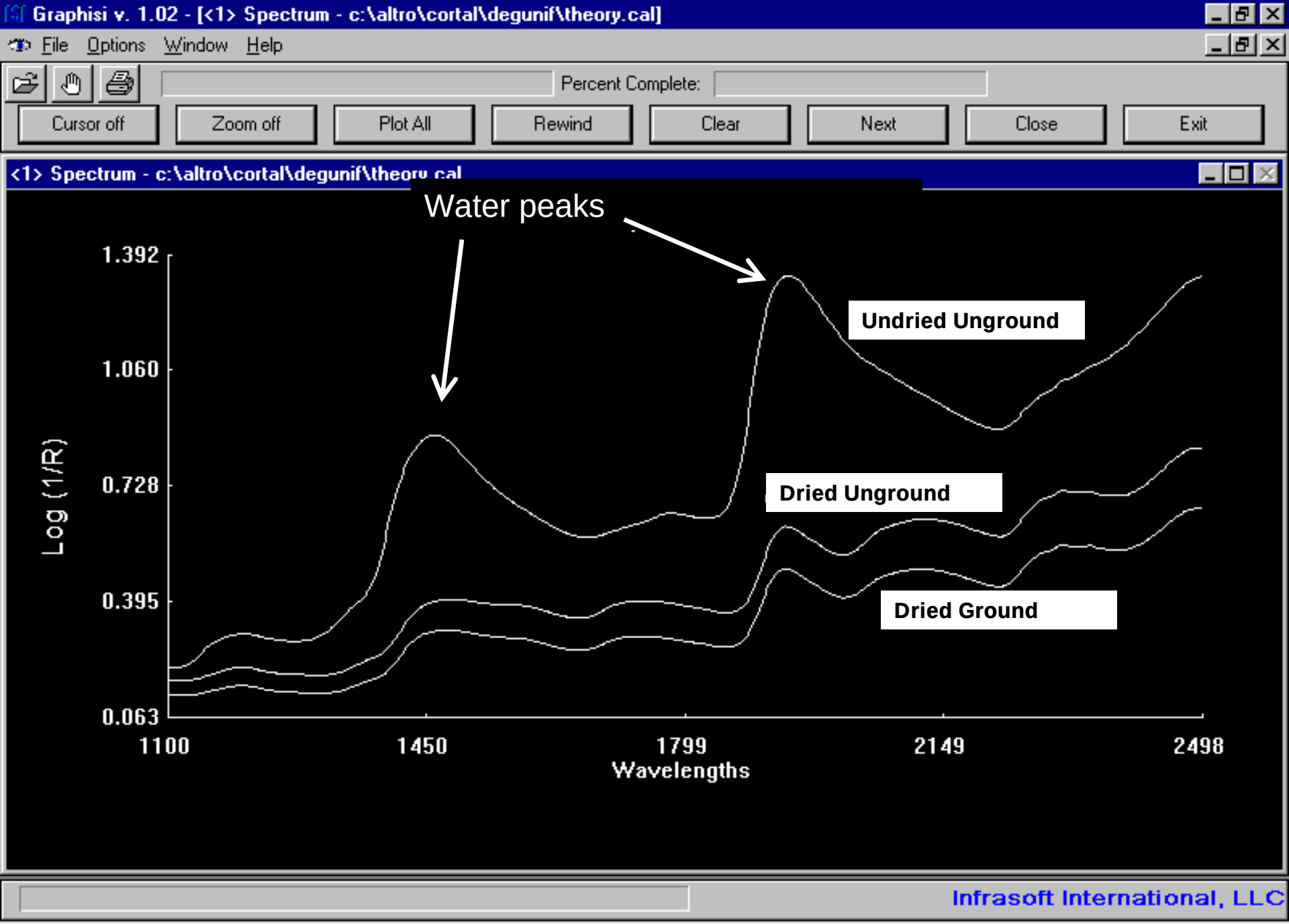
- Laboratory instruments
  - Monochromators (grating instruments)
  - Interferometers (Fourier Transform – FT)
- Portable sensors
  - Diode arrays

# Slit - monochromator systems



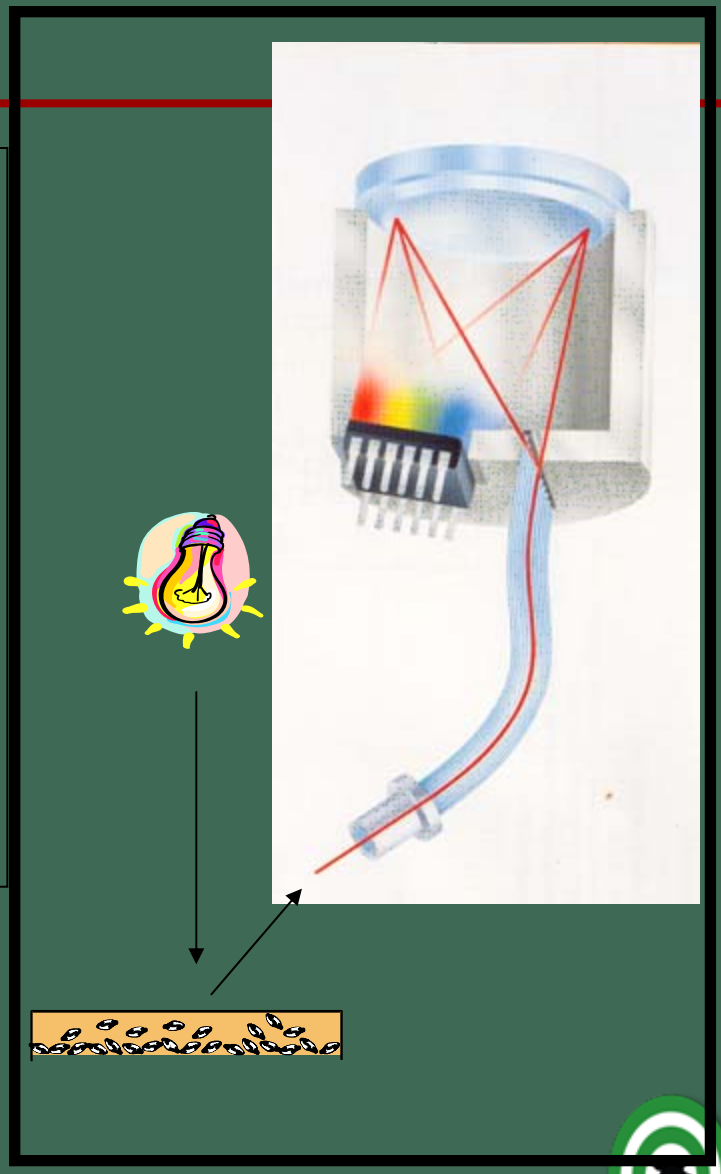

- Moving parts
- Pre-dispersive
- PbS or InGaAs detectors
- Slow scanning (1 sec)
- Highly accurate
- 400-1098; 1100-2498nm
- Every 2nm

# Laboratory Instruments

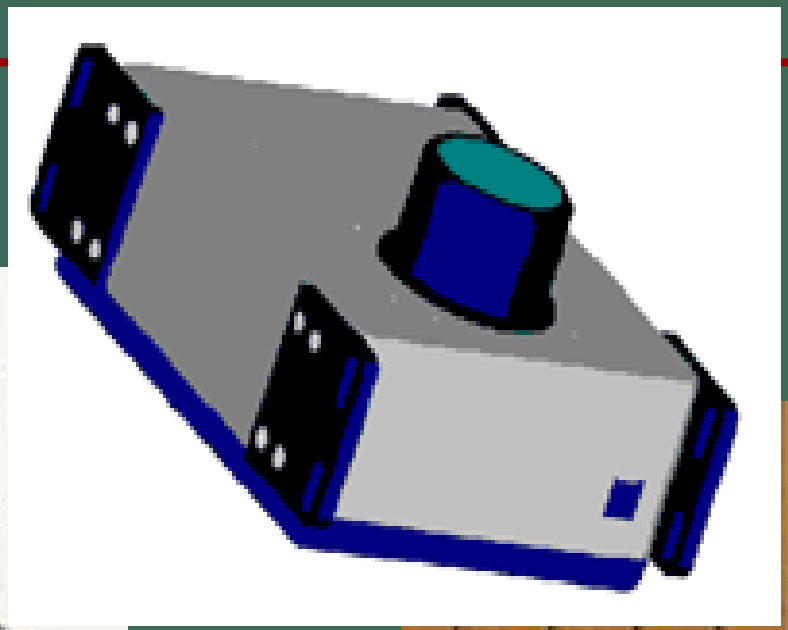

Graphisi v. 1.02 - [<1> Spectrum - c:\altro\cortal\degunif\theory.cal]
File Options Window Help
Percent Complete:
Cursor off
Zoom off
Plot All
Rewind
Clear
Next
Close
Exit
<1> Spectrum - c:\altro\cortal\degunif\theory.cal
Water peaks
Undried Unground
Dried Unground
Dried Ground
1.392
1.060
0.728
0.395
0.063
Log (1/R)
1100
1450
1799
2149
2498
Wavelengths
Infrasoft International, LLC
Avvio
Posta in arri...
C:\Altro\Co...
WinISI II Pr...
Microsoft P...
File View v....
Graphisi ...
16.51

# Diode Array

- No moving parts
- Post-dispersive
- 800-1100nm
  - Silicon detector (low cost)
- 900-1700nm
  - InGaAs detector (expensive)
- Fast scanning (10 ms)
- Very accurate

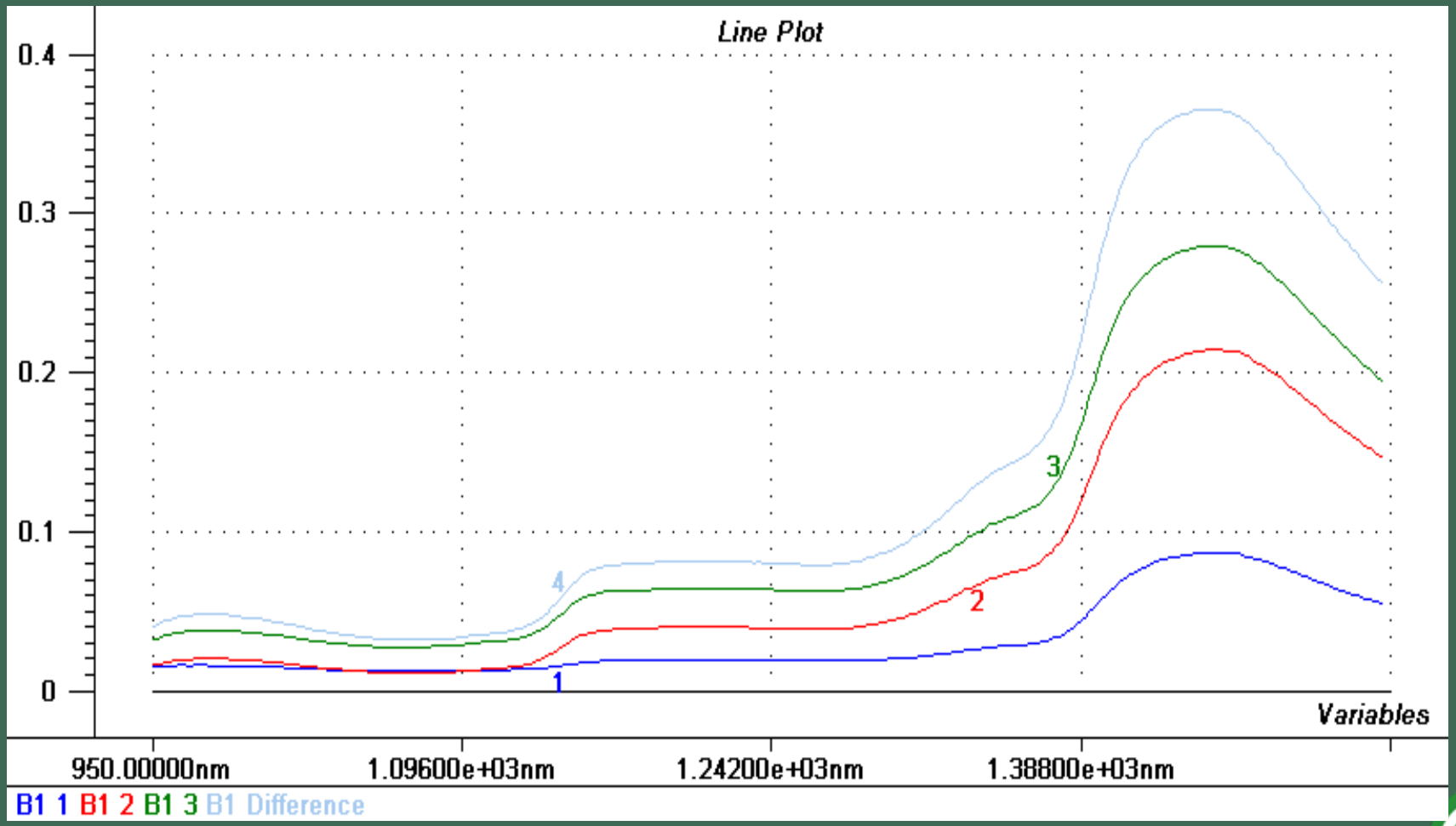


# Diode Array Sensors



# Water Has a Strong NIR Absorbance

## Spectral changes of a forage during drying



# Monochromator vs Diode array

Monochromator

**Lab bench instrument**

**Dedicated (sample presentation not modifiable)**

**Expensive (35-50K USD)**

**Good equation transferability**

Diode arrays

**Rugged instrument**

**Sample presentation more flexible**

**Less expensive (15-35K USD)**

**Equation transferability is more difficult**

# Objectives

- Develop rapid on-farm DM method of analysis based on diode array near infrared sensors
- Monitor forages and TMR composition overtime
- Evaluate effects of single day changes in feed composition and feed allowance on milk production

# Materials and Methods

10 weeks: 8 experimental wks + 2 wks of rest

Daily sampling of forages (corn and alfalfa silages) and TMRs;

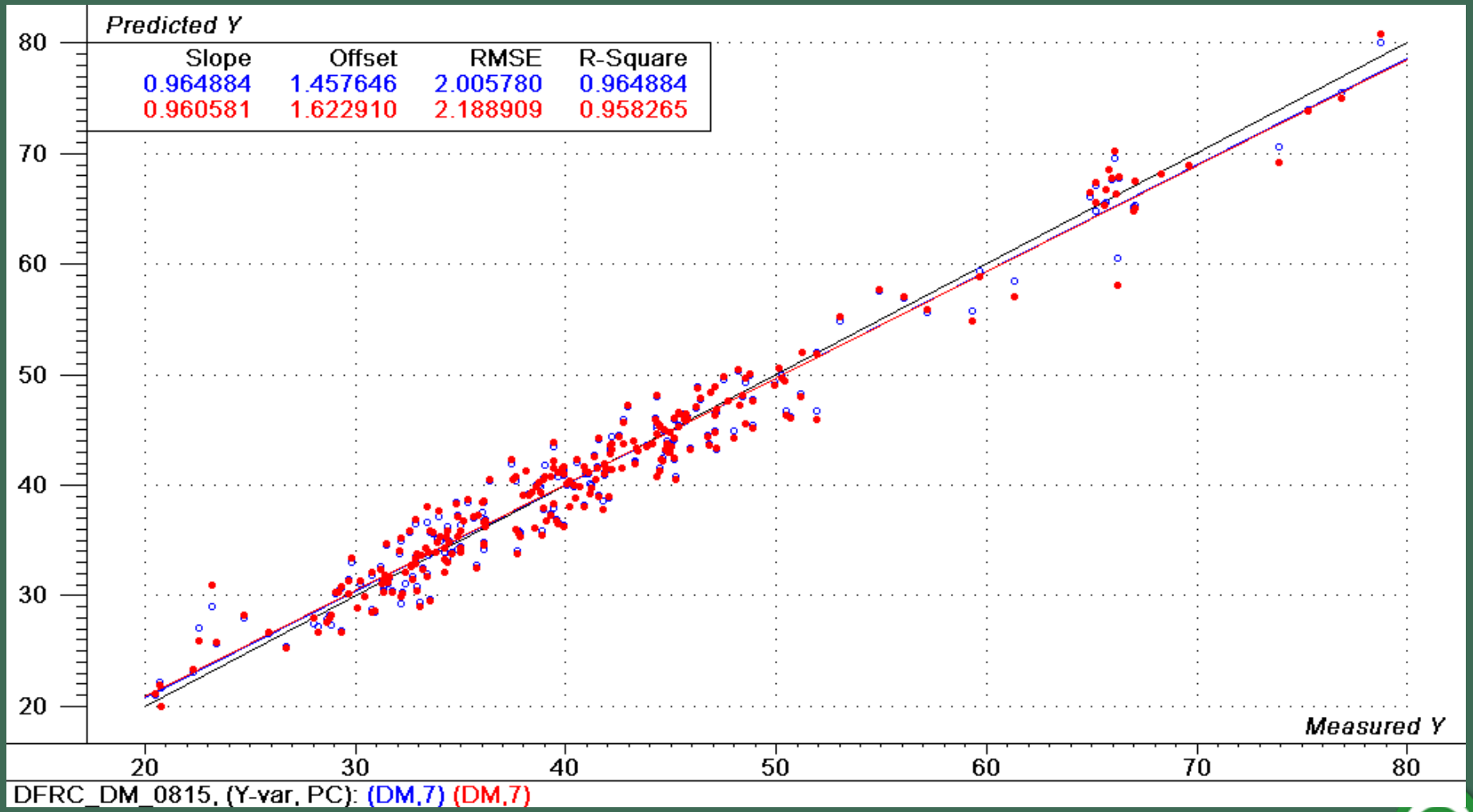
Weekly sampling of concentrates;

Immediately after collection, forage samples were scanned in duplicate using a diode array sensor (HarvestLab™, Deere & Company);

In-house DM calibration for the sensor was developed with Unscrambler 9.7:

- SECV=2.2 % $R^2$=0.95

# Large Range, Multi-Product Calibration



# John Deere HarvestLab™

- Diode array w/ 128 diodes
- Range 960-1550nm
- Fast scanning (11.5 ms)
- Internal reference
- Large glass bowl (200 mm)
- Spinning bowl
- 5s scan per bowl
- Disclaimer – information provided for description only

# Material and Methods

After scanning, samples were dried (55 °C), ground (1mm Wiley), and scanned on a Foss 6500 grating monochromator NIRS (Foss NorthAmerica);

Forages and TMR analyzed by NIRS using an updated (30 samples) in-house (USDFRC) calibration equation:

- aNDFom SECV = 0.89%DM $R^2$ = 0.99
- CP SECV = 0.42%DM $R^2$ = 0.99

Weekly samples of concentrates were analyzed by AOAC Official Methods

# Material and Methods

48 cows (selected to represent a typical herd distribution)

- Parity = 2.3±1.1
- Days-in-lactation = 138 ±52
- Body weight = 592 ±63kg

Blocked by parity and DIM and assigned to either a Control or a Treatment (TRT) group;

Control: TMR adjusted for forage DM changes daily using an exponential moving average

Treatment: Forage DM changed one day per experimental week

# Ingredient Composition of the TMR

| Ingredient | % of DM |
|---|---|
| Alfalfa Silage | 27.00 |
| bmr Corn silage | 25.00 |
| HMCorn | 28.00 |
| Roasted SB | 10.00 |
| SBM, 48% | 2.50 |
| Distillers grains | 5.00 |
| Blood meal | 1.00 |
| LactoMin[a] | 1.50 |

# Experimental week

| | BASELINE | | CHG | RECOVERY | | |
|---|---|---|---|---|---|---|
| d1 | d2 | d3 | d4 | d5 | d6 | d7 |

**BASELINE** – ***ad-lib.*** **(110% of intake)**

**Change (CHG)** – ⇓ **offered feed or forage DM chg**

**RECOVERY** – ***ad-lib.*** **(110% of intake)**

# Treatments During the Day of Change

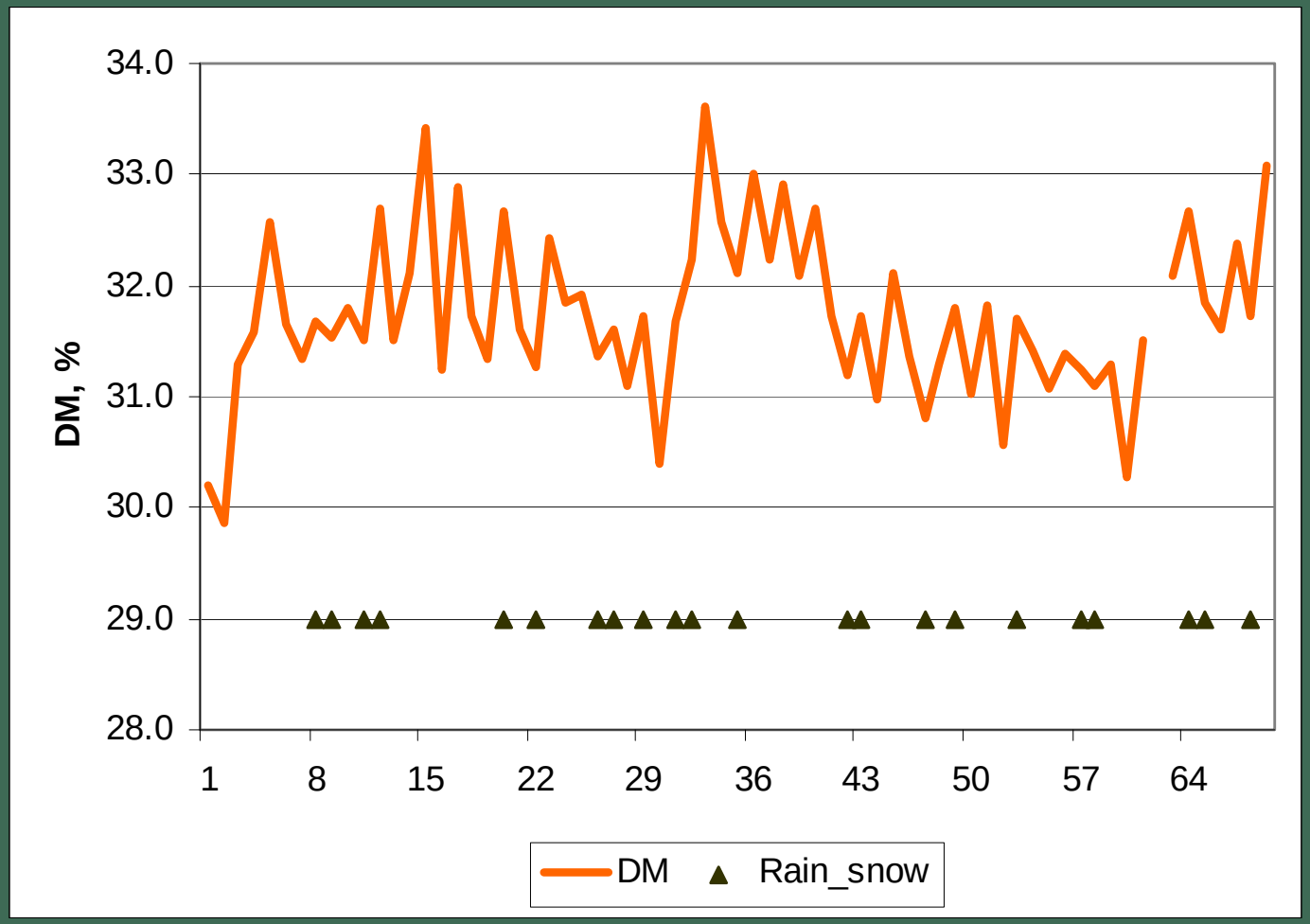
- **Experimental ration with feed reduced to 88%**
- **Reduce the DM of CS & AS by 8%-units by adding water** (repeated)
- **Diet equal to Trt 2 without adding the water**
- **Reduce DM of CS only by 16%-units by adding water** (repeated)
- **Reduce DM of AS only by 16%-units by adding water**
- **Reduce the DM of CS & AS by 16%-units by adding water**

# Materials and Methods

- Cows were fed individually once a day
- Feed offered and refusals were measured daily
- Milking 2X
- Milk samples at each milking on d2-d6
- Intake and milk production expressed as difference from baseline (d2 and d3)
- Proc Mix with Cow as random variable within Block X Treatment group;

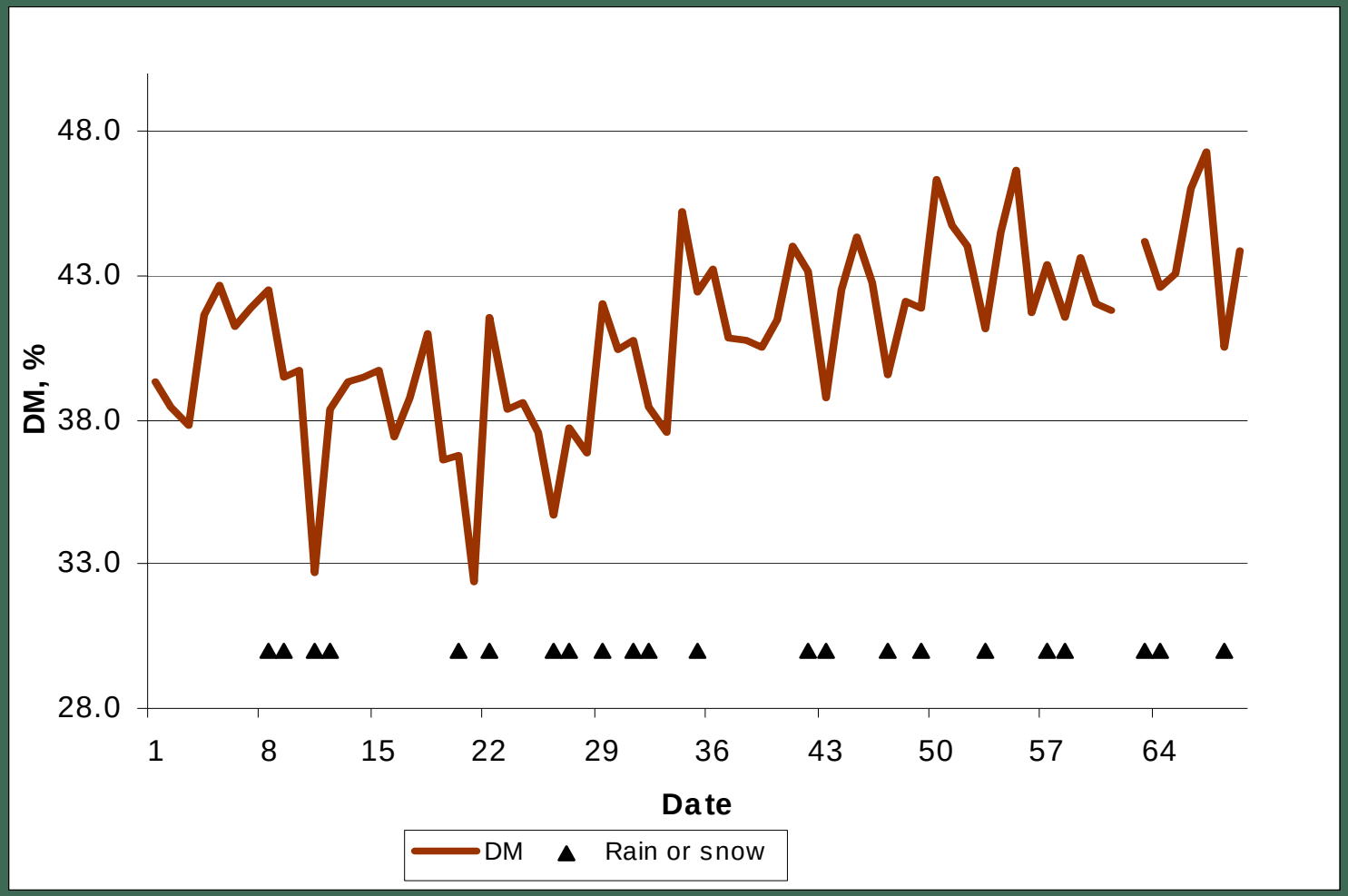
# Variation in DM content of corn silage

**AVG= 31.4 % ; SD= 0.74**

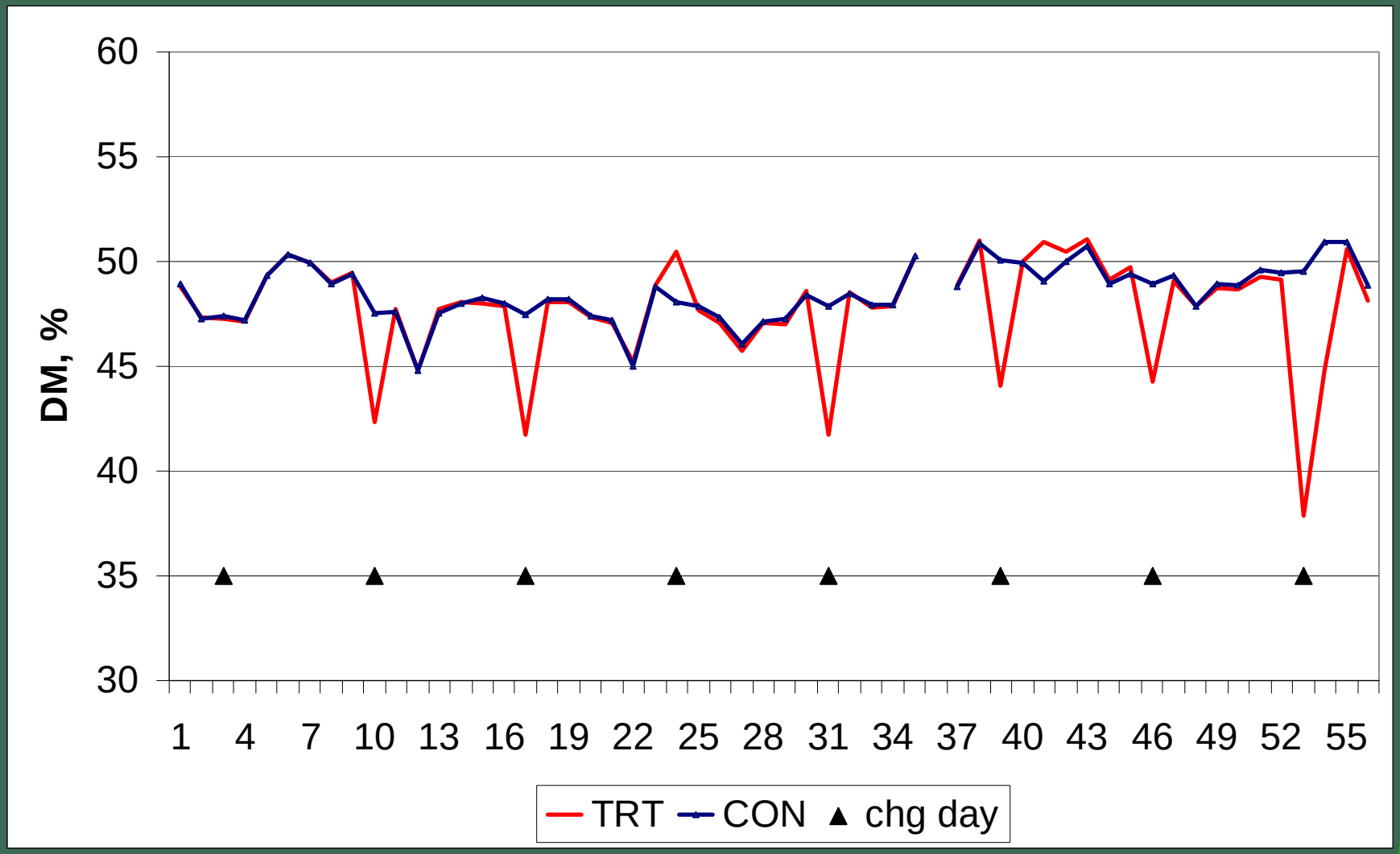


# Variation in DM content of alfalfa silage

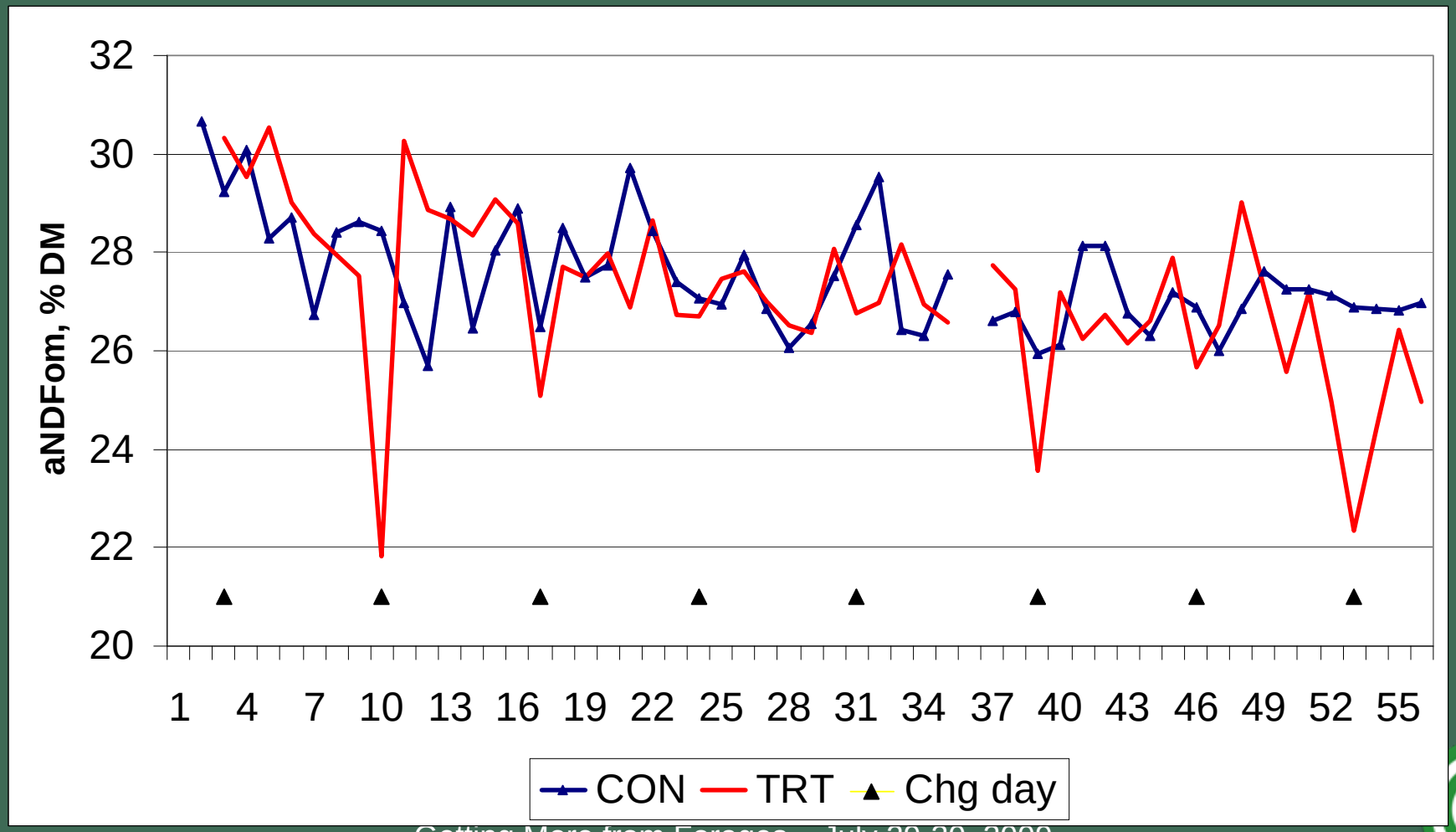
**AVG= 41.0 % ; SD= 3.04**



# Variation in DM content of TMR



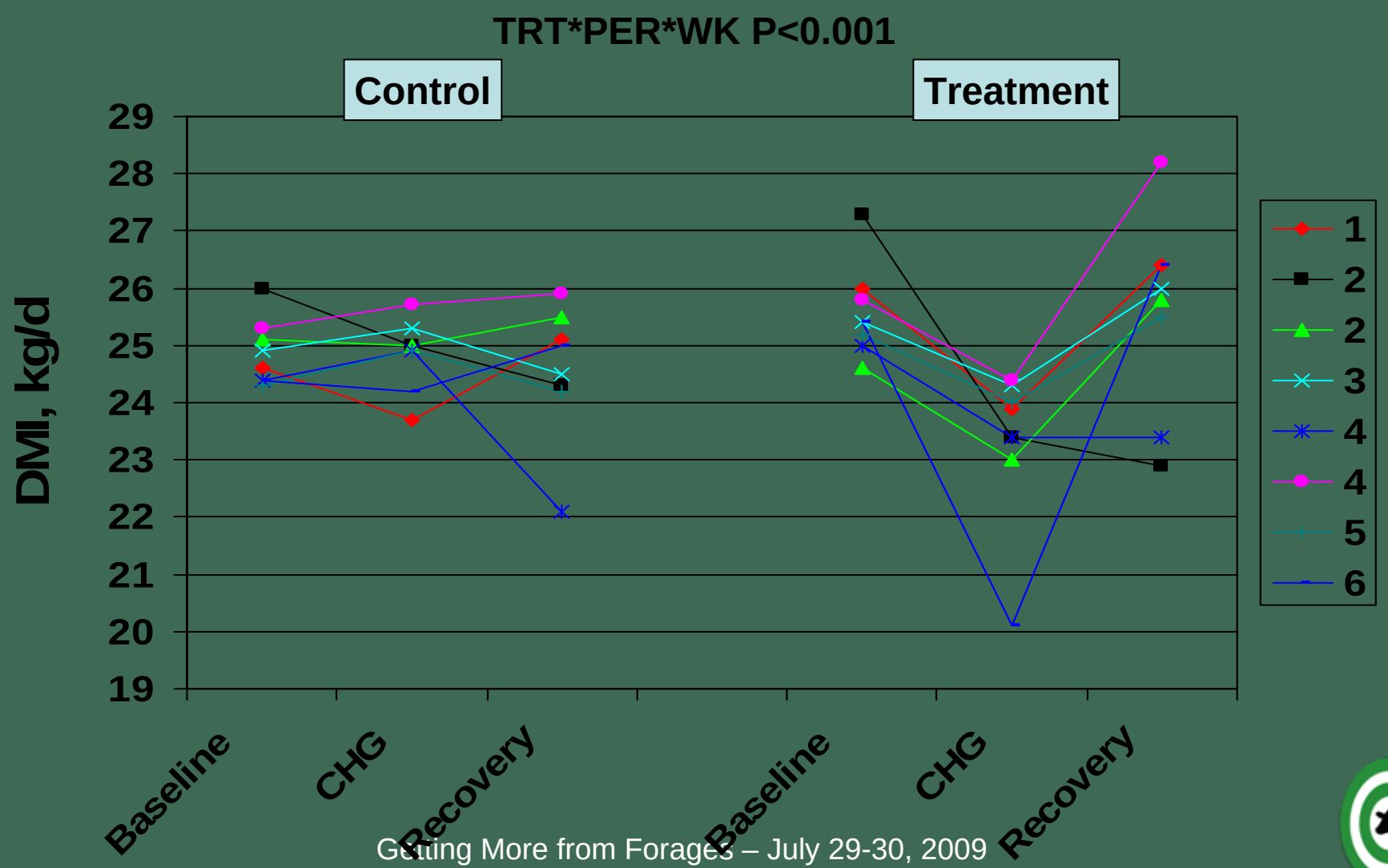
# Variation in aNDFom content of TMR



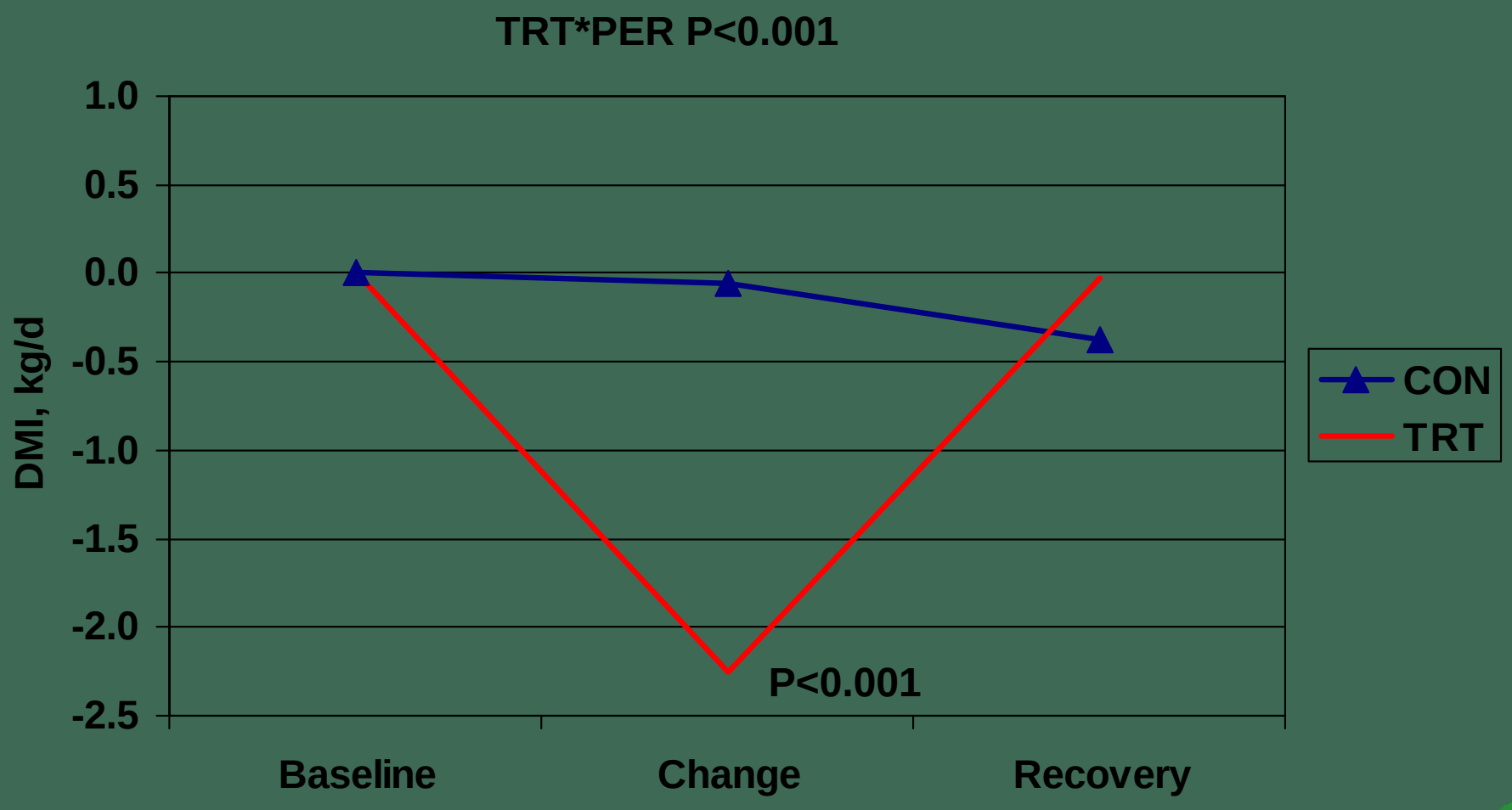
# Stats of Composition

| | | n | AVG | SDEV | Min | max |
|---|---|---|---|---|---|---|
| AS | DM, % | 68 | 41.0 | 3.04 | 32.4 | 47.3 |
| AS | aNDFom, %DM | 53 | 37.0 | 2.30 | 32.7 | 41.0 |
| AS | CP, %DM | 53 | 22.0 | 1.25 | 19.4 | 24.2 |
| CS | DM, % | 68 | 31.4 | 0.74 | 28.9 | 33.0 |
| CS | aNDFom, %DM | 50 | 40.4 | 1.77 | 37.0 | 44.7 |
| CS | CP, %DM | 50 | 7.8 | 0.26 | 7.3 | 8.3 |
| TMR_CON | DM, % | 55 | 48.5 | 1.33 | 44.8 | 50.9 |
| TMR_CON | aNDFom, %DM | 55 | 27.5 | 1.13 | 25.7 | 30.7 |
| TMR_CON | CP, %DM | 55 | 17.0 | 0.62 | 15.6 | 18.6 |
| TMR_TRT | DM, % | 55 | 47.7 | 2.58 | 37.9 | 51.1 |
| TMR_TRT | aNDFom, %DM | 52 | 27.1 | 1.78 | 21.8 | 30.5 |
| TMR_TRT | CP, %DM | 52 | 17.0 | 0.68 | 15.6 | 19.3 |

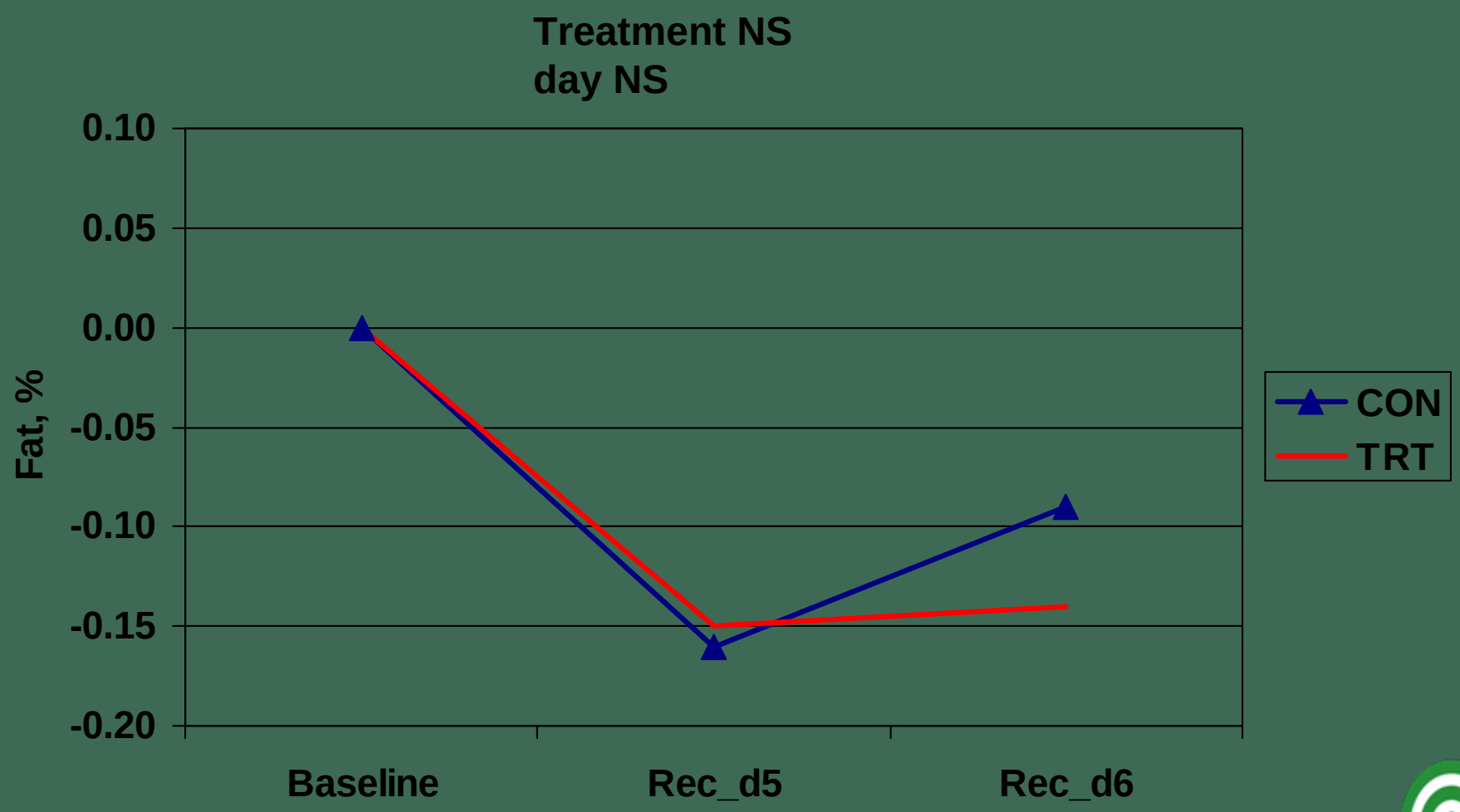
# Changes in DM Intake: by TRT



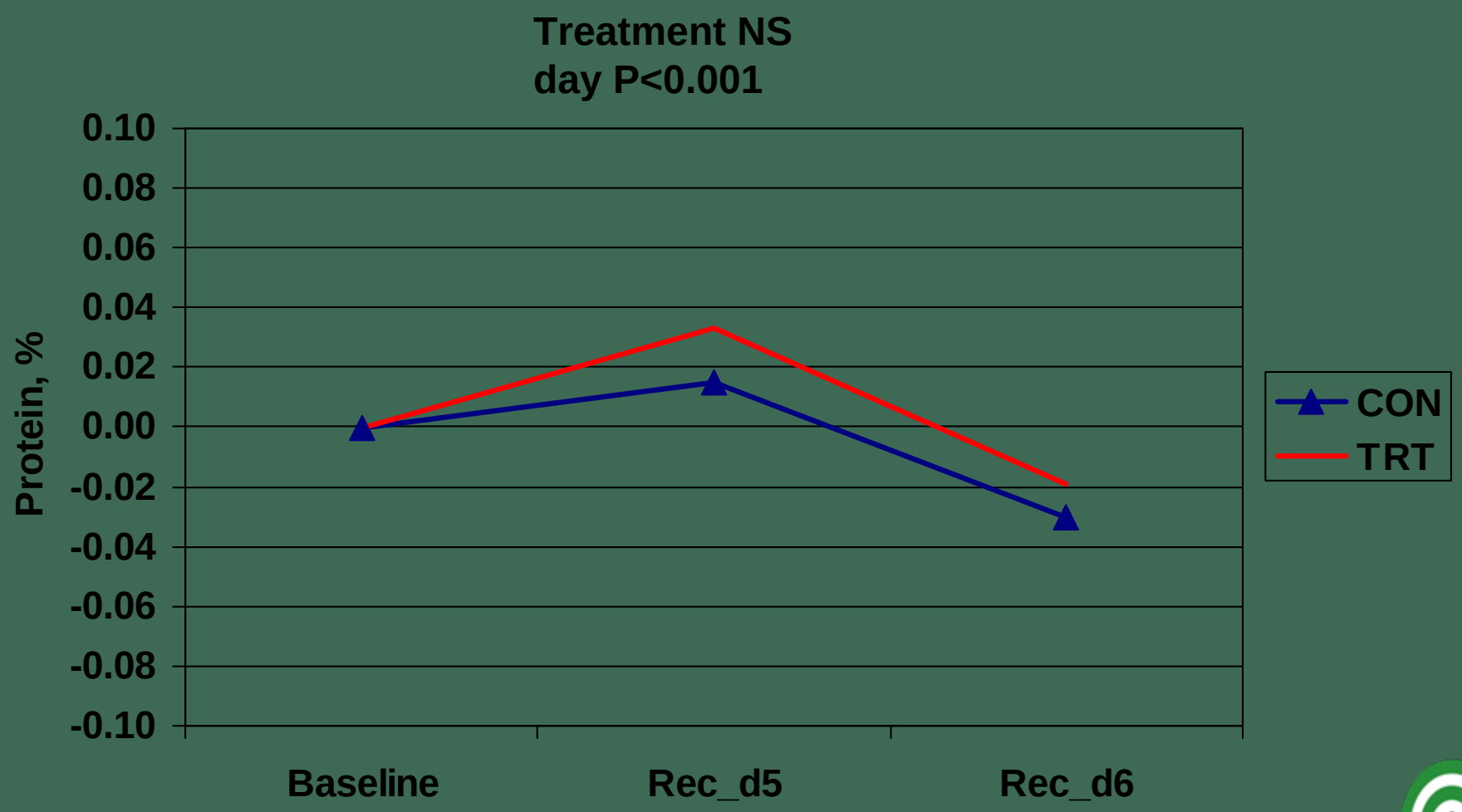
# Changes in DM Intake relative to baseline



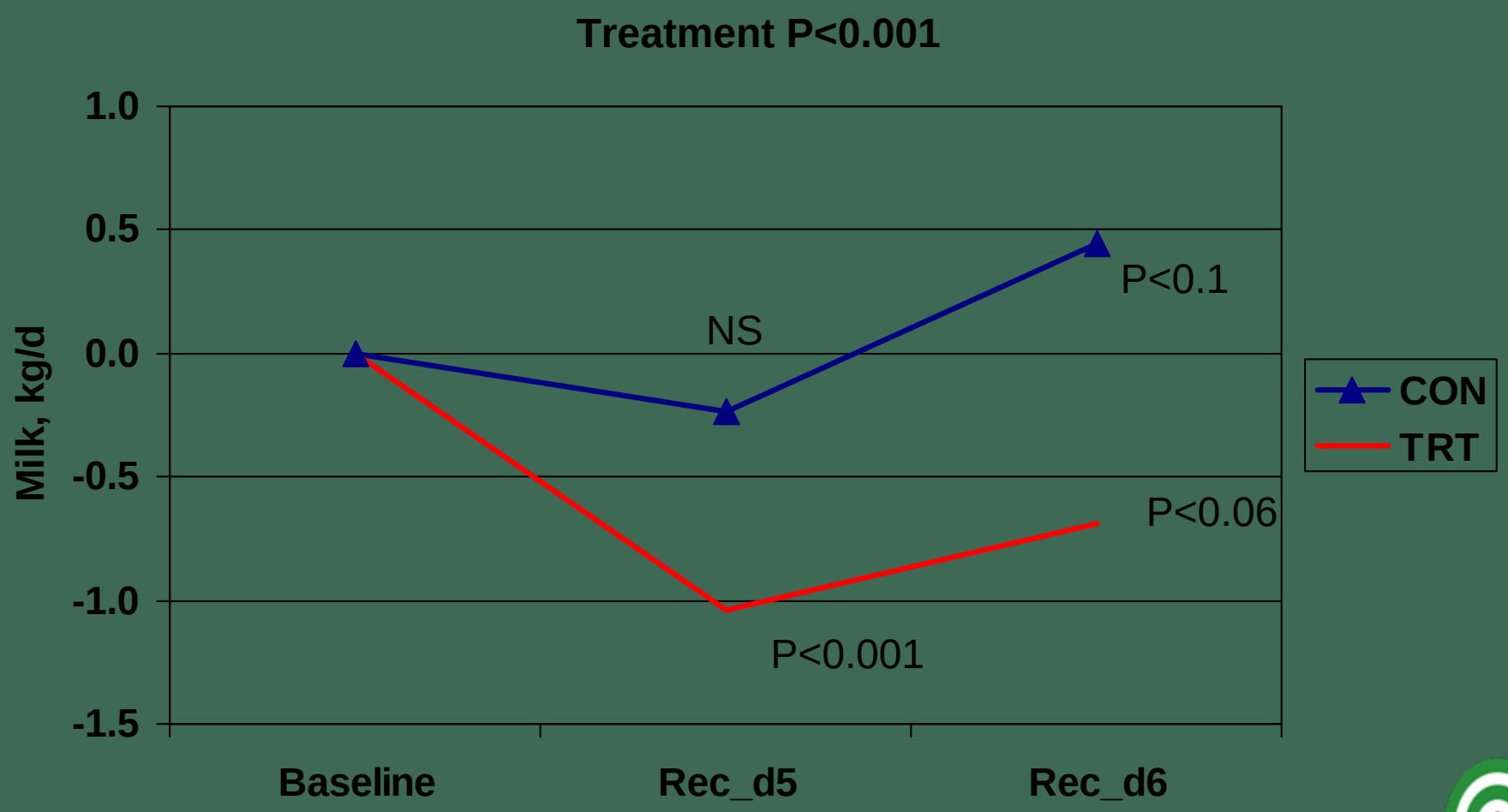
# Changes in milk fat relative to baseline



# Changes in milk protein relative to baseline



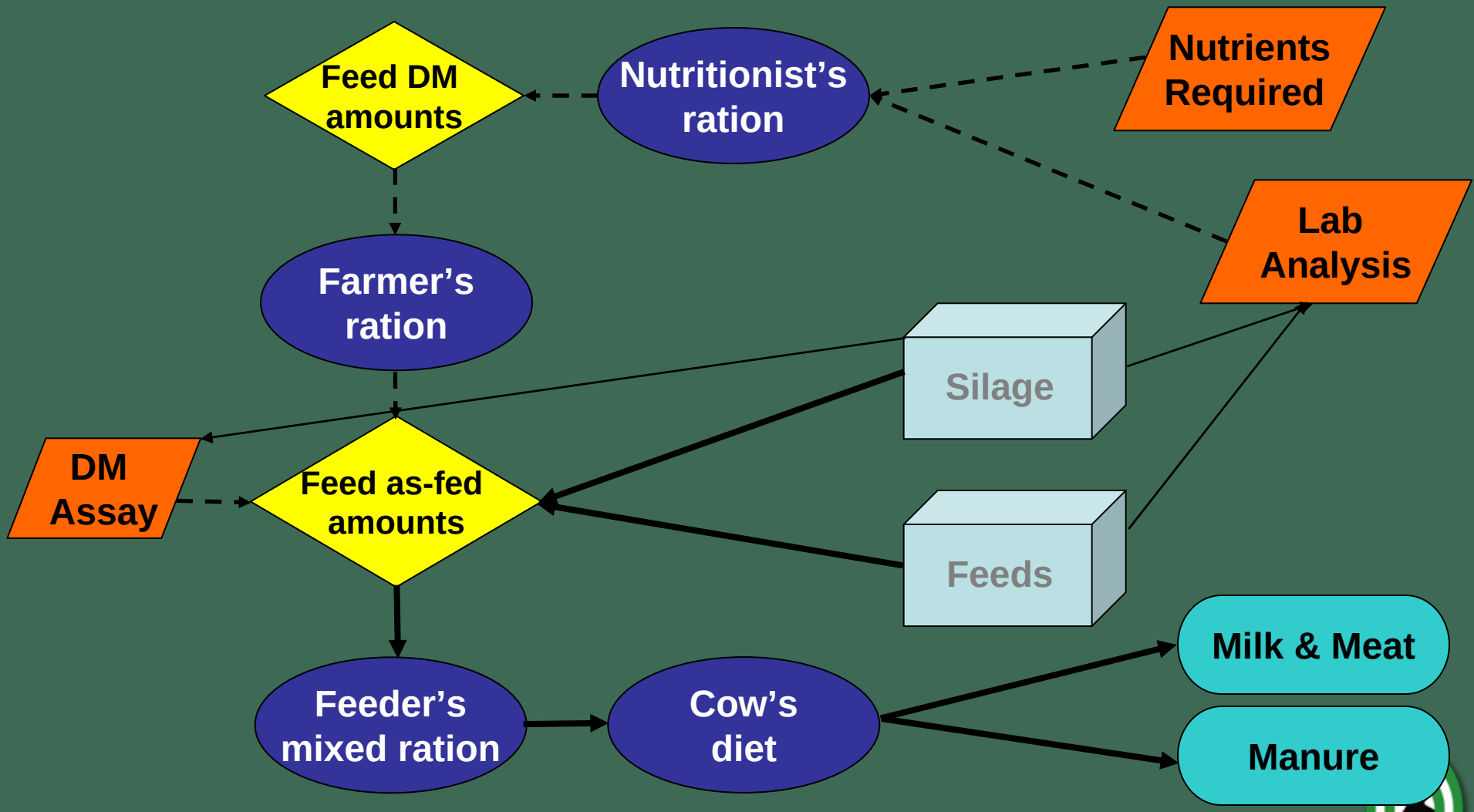
# Changes in Milk Yield relative to baseline



# Conclusions

- Day to day DM variation in forages is unavoidable and can be large
- On-farm, rapid methods of analysis based on rugged NIR instruments can help managing such variation
- Use of these instruments must also consider integration of feed composition with feed mixing software (i.e. EZfeed, Feedwatch,……)

# Cycle of Feeding
# What ration is the cow really getting?



# Conclusions

- Single day variations in forage composition have an immediate effect on DM intake;
- For decrease in DMI of one kg in a single day, 0.8 kg of milk is lost in each of the following two days
- Other detrimental effects of forage variation not accounted in this trial include animal health and nutrient excretion

# Getting More from Forages

## Targeted feeding strategies:

### Accounting for variability

# Adjusting for forage variability via on-farm analysis

**Questions?**

**David Mertens**
**Paolo Berzaghi**