

Using Forage Fiber Analyses to Get the Most from Your Cows

Rick Grant

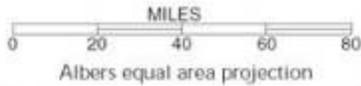
W. H. Miner Agricultural Research Institute

Chazy, NY



**Where is Miner
Institute?**





New York State Map



▲ **CHAZY**

William H. Miner Agricultural Research Institute

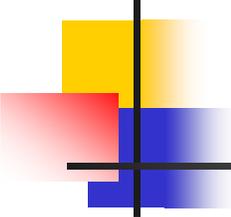


William Miner stated nearly a century ago:



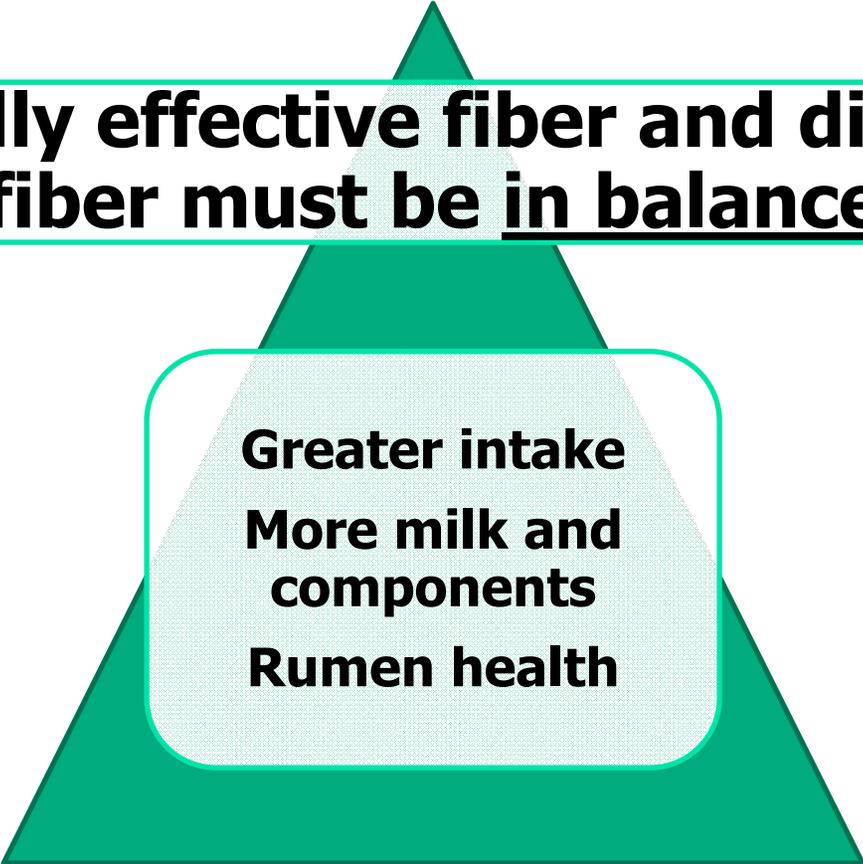
“Agriculture is the fundamental occupation.”

“No other occupation is so vitally important to the human race, nor requires such a wide range of practical and technical knowledge...”



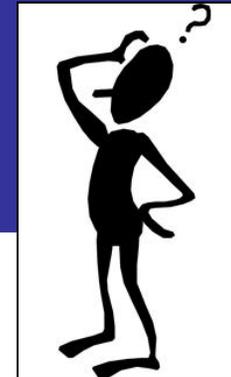
Forage Fiber Concepts

Physically effective fiber and digestible fiber must be in balance



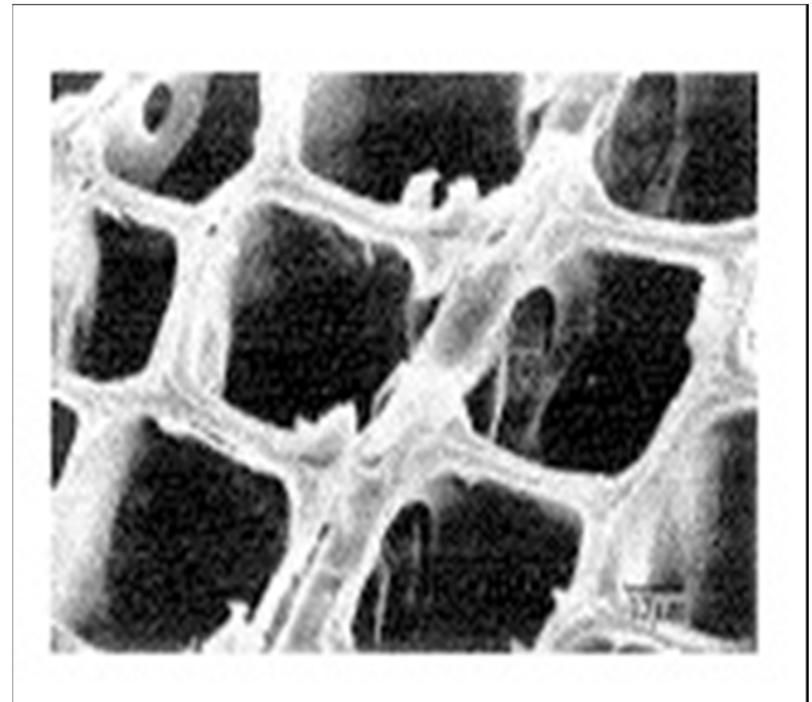
**Greater intake
More milk and
components
Rumen health**

**What Forage Fiber
Analyses Should We
Use ...
What Do They Mean
to the Cow?**

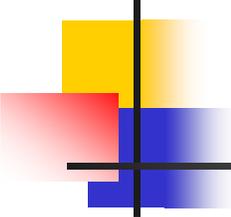


Characterizing Forage Fiber Quality

- **NDF, Lignin/NDF**
- **NDF digestibility**
 - **In vitro “artificial rumen” ≠ in vivo**
 - **24, 30, 48 hours?**
- **Indigestible NDF**
 - **Needed for measuring rate of digestion**
 - **(Lignin x 2.4) or 240 hours?**
- **Physically effective NDF**

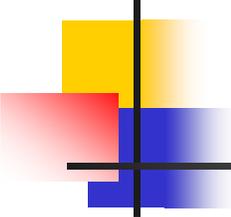


Stem cross-section



How Do We Use NDF Digestibility Measurements?

- **Relative ranking by NDFD**
 - Hybrid/cultivar selection
 - Benchmarking
- **Troubleshooting feeding problems**
- **Allocation of forages**
- **Adjust forage energy values**
- **Use in nutritional models for ration formulation**
- **Optimize forage inclusion in diet**



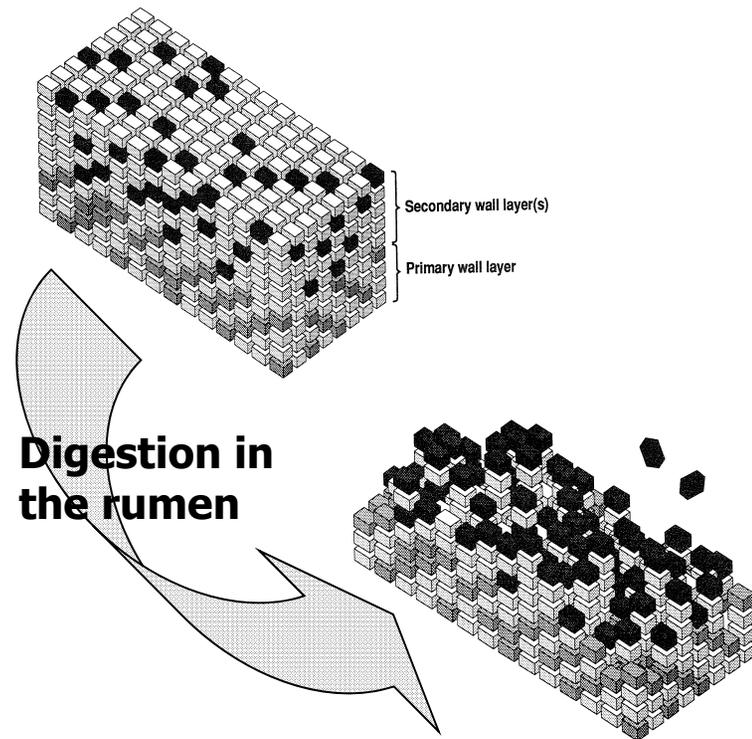
Crude Protein DOES NOT Predict Forage Digestibility (Van Soest, 1994)

| Fraction | r |
|-------------------------|--------------|
| Crude protein, % | 0.24 |
| ADF, % | -0.79 |
| NDF, % | -0.81 |
| L/NDF, % | -0.90 |

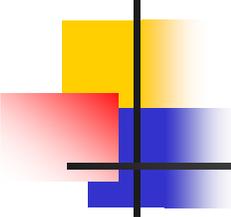
➤ **L/NDF or L/ADF most accurately predicts DMD**

Target L/NDF Ratios

- **Alfalfa**
 - **Range: 11-20%**
 - **Goal: <15%**
- **Corn silage**
 - **Range: 3-9%**
 - **Goal: <6%**
- **Grass silage**
 - **Goal: <9%**



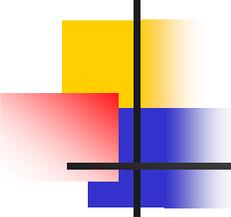
Lignin="plant plastic"



Measured NDFD or Estimation from Lignin?

| NDF, % | Lignin, % | 30-h NDFD |
|---------------|------------------|------------------|
| 45.0 | 3.52 | ? |
| 45.0 | 3.26 | ? |
| 45.0 | 3.32 | ? |
| 45.1 | 3.18 | ? |
| 45.0 | 3.43 | ? |

- **Corn silage data set from Van Amburgh (2005)**
- **Similar relationships from 36.5 to 51.8% NDF**



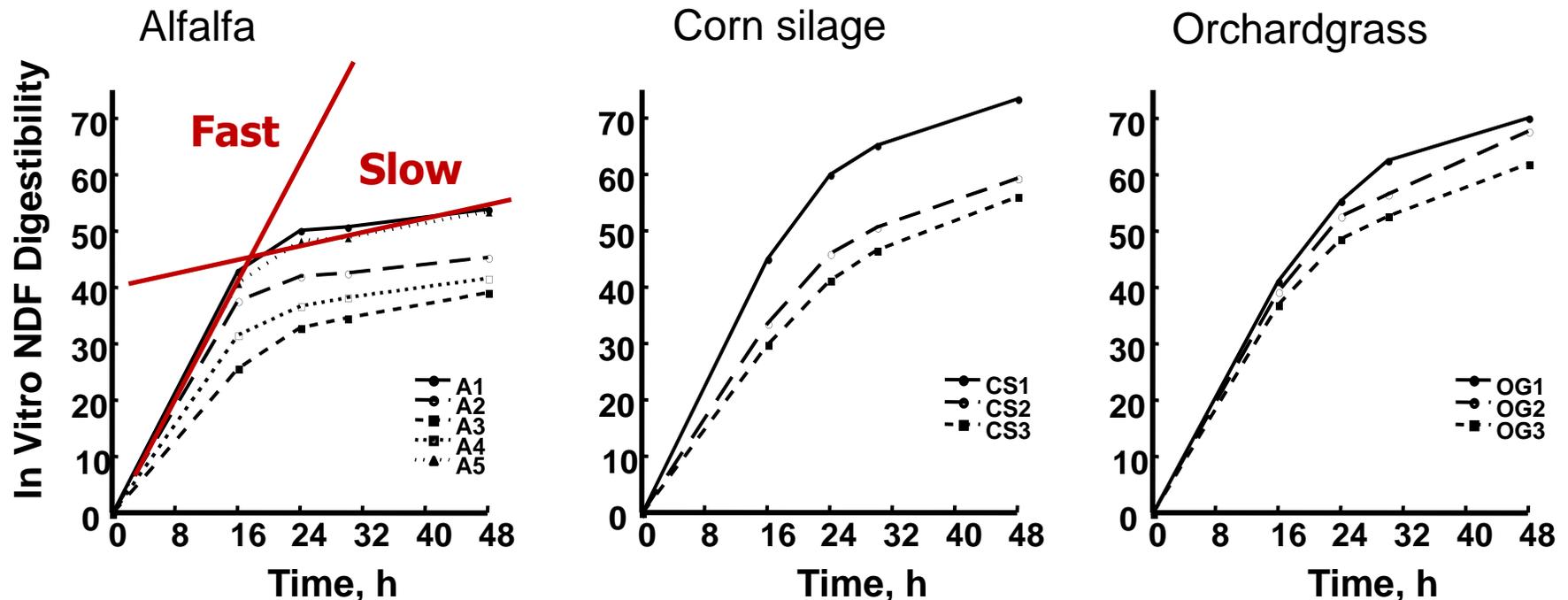
Measured NDFD or Estimation from Lignin?

| NDF, % | Lignin, % | 30-h NDFD |
|---------------|------------------|------------------|
| 45.0 | 3.52 | 46.0 |
| 45.0 | 3.26 | 48.4 |
| 45.0 | 3.32 | 54.4 |
| 45.1 | 3.18 | 55.0 |
| 45.0 | 3.43 | 67.3 |

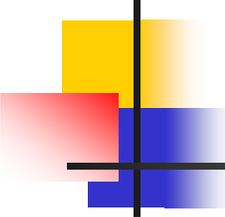
- **Corn silage data set from Van Amburgh (2005)**
- **Similar relationships from 36.5 to 51.8% NDF**

Note “fast” and “slow” pools in these digestion curves

(Allen, 2005, unpublished)



- For many forages, digestion curves are ~parallel from 24 to 48 h
- Can use several time points for benchmarking
- Pick one and be consistent

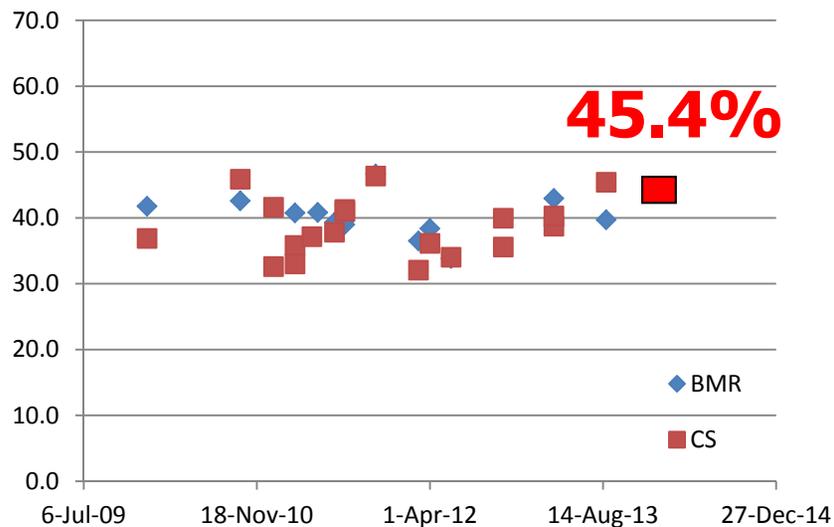


Current Measurement of Fiber Digestion ...

- Measure NDF and lignin
- Measure NDF digestion at 30, 120, and 240 hours of in vitro fermentation
- Predict:
 - Indigestible NDF
 - Overall rate of NDF digestion
 - Fast and slow NDF digestion
- iNDF + slow NDF determine rumen fill
- **Closer to reality? Closer to what cows are telling you?**

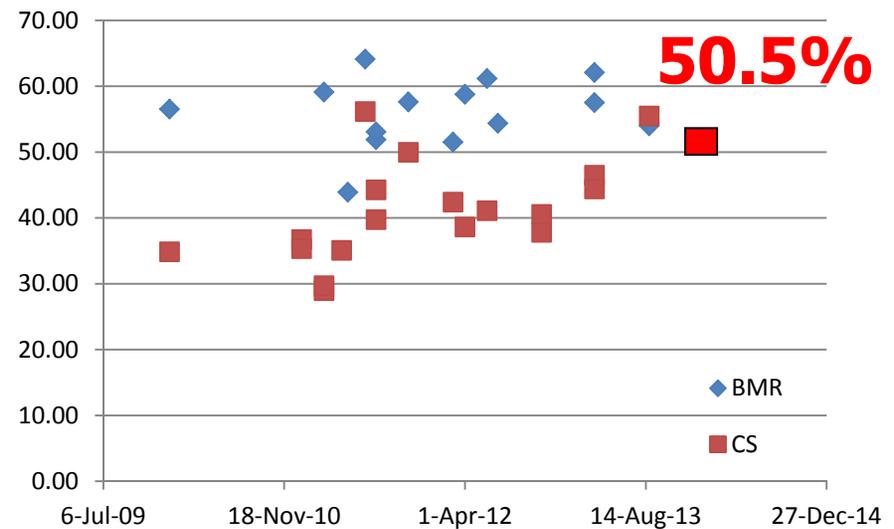
Corn silage NDF and NDF digestibility at Miner Institute

Conventional/BMR CS NDF%



BMR CS: 40.0% NDF
Conv CS: 38.5% NDF

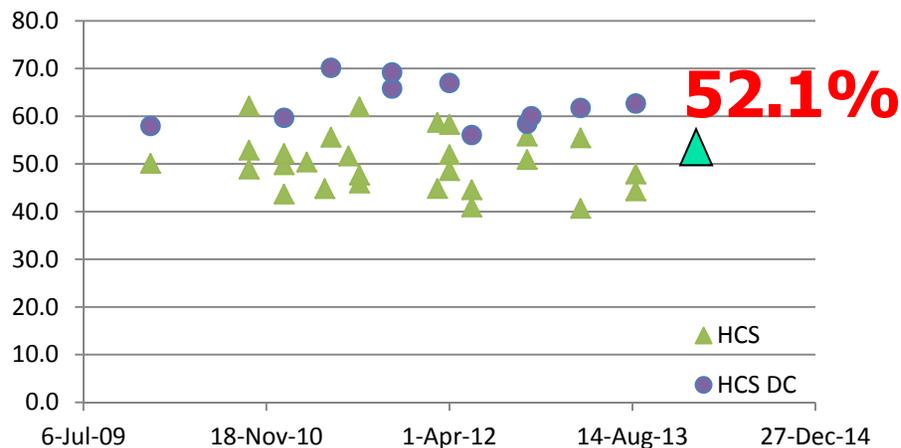
Conventional/BMR CS NDFD24



BMR CS: 56.1% NDFD
Conv CS: 41.0% NDFD

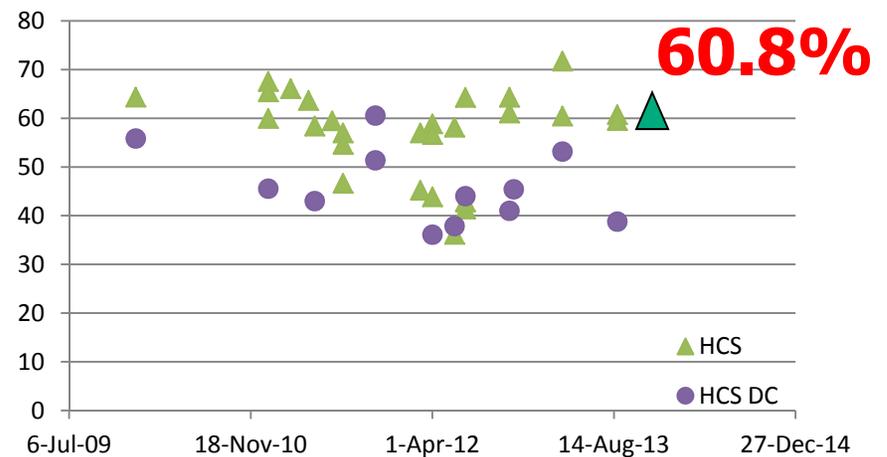
Haycrop silage NDF and NDF digestibility at Miner Institute

Haycrop Silage NDF%



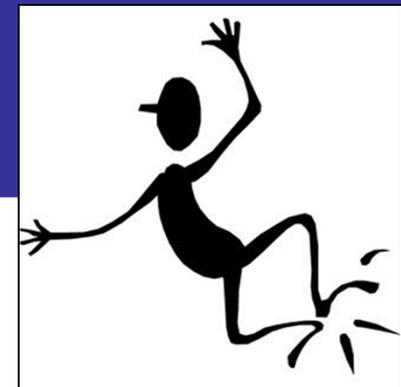
HCS: 50.4% NDF
HCS DC: 62.6% NDF

Haycrop Silage NDFD24

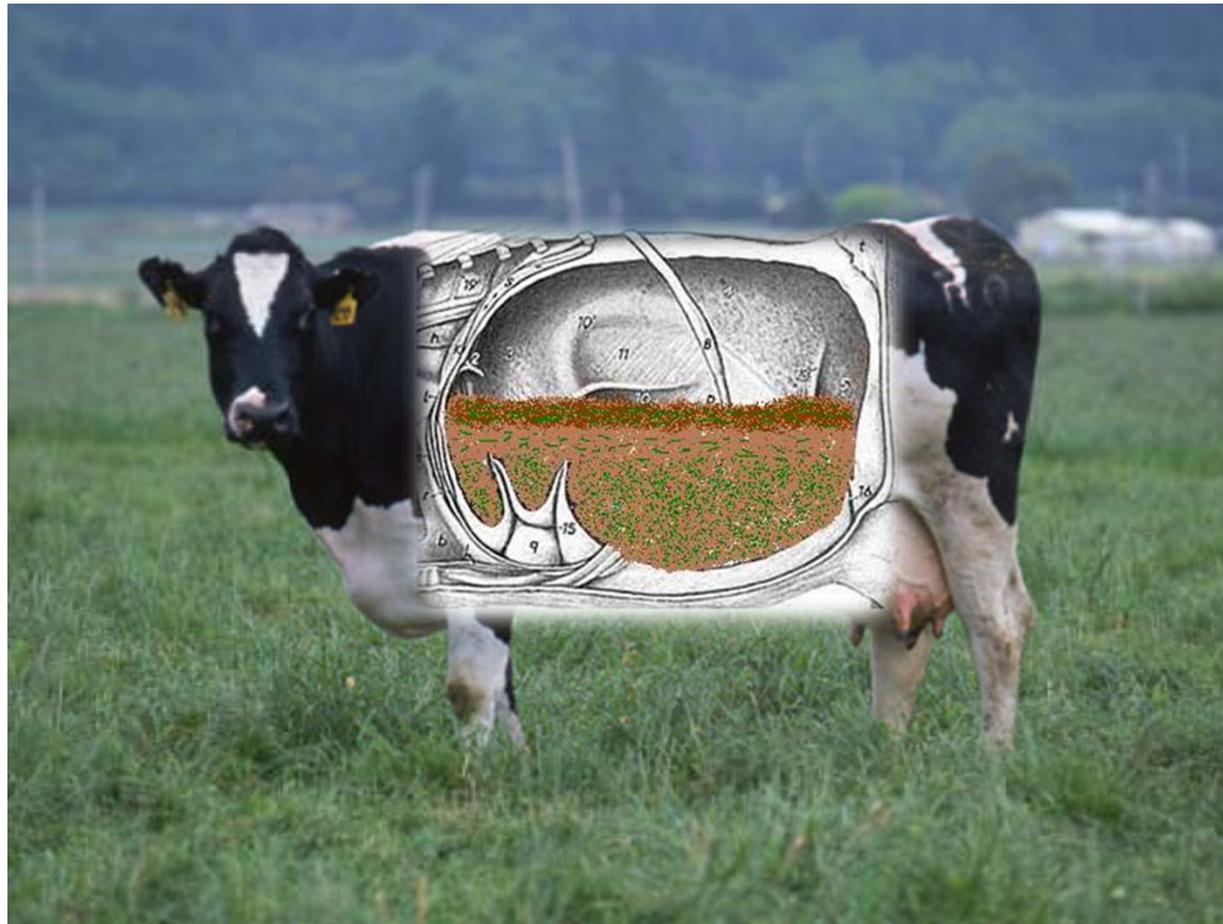


HCS: 57.2% NDFD
HCS DC: 46.1% NDFD

Getting the Greatest Response from Your Cows to Higher Forage-Fiber Digestibility

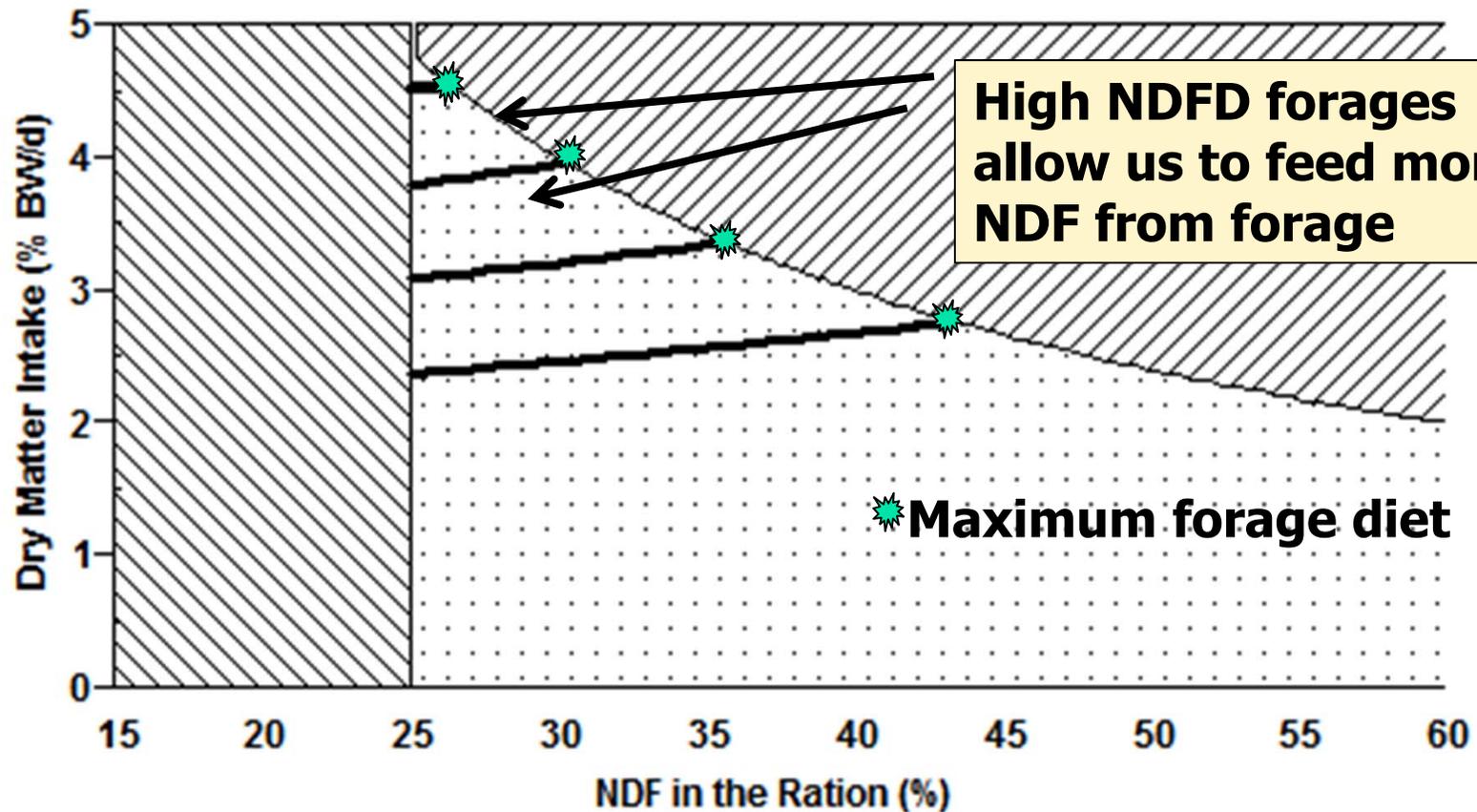


Rumen Fill Dynamics



High forage NDF digestibility increases maximum forage

(Mertens, 2009)



How high can you go?

Depends on digestibility

(Mertens and Huhtanen, 2007)

- Forage mix of 25% alfalfa (40% NDF):75% grass (55% NDF)

| Target milk (lb/d) | 77 | 88 | 99 |
|----------------------------|----|----|----|
| Grass 48-h NDFD <u>60%</u> | | | |
| Forage, % of diet | 61 | 54 | 48 |
| Grass 48-h NDFD <u>76%</u> | | | |
| Forage, % of diet | 71 | 63 | 55 |

+10% (from 54 to 63)
 +9% (from 63 to 71)
 +7% (from 48 to 55)

How high can NDF digestibility go?

65-80% for grasses

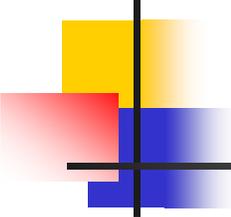
50-60% for legumes

How Much Forage is Being Fed to Dairy Cows? (Chase, 2012)

| | A | B | C | D | E | F | I | N | Pasture |
|----------------|------|------|------|------|------|------|------|------|---------|
| Milk (lb) | 80 | 90 | 75 | 90 | 85 | 90 | 100 | 85 | 49 |
| % Forage | 58 | 58 | 59 | 59 | 67 | 58 | 82 | 57 | 100 |
| F-NDF, % of BW | 0.93 | 1.06 | 1.04 | 0.96 | 1.16 | 0.88 | 1.00 | 1.02 | 1.80 |

➤ **How much Forage-NDF can a dairy cow consume?**

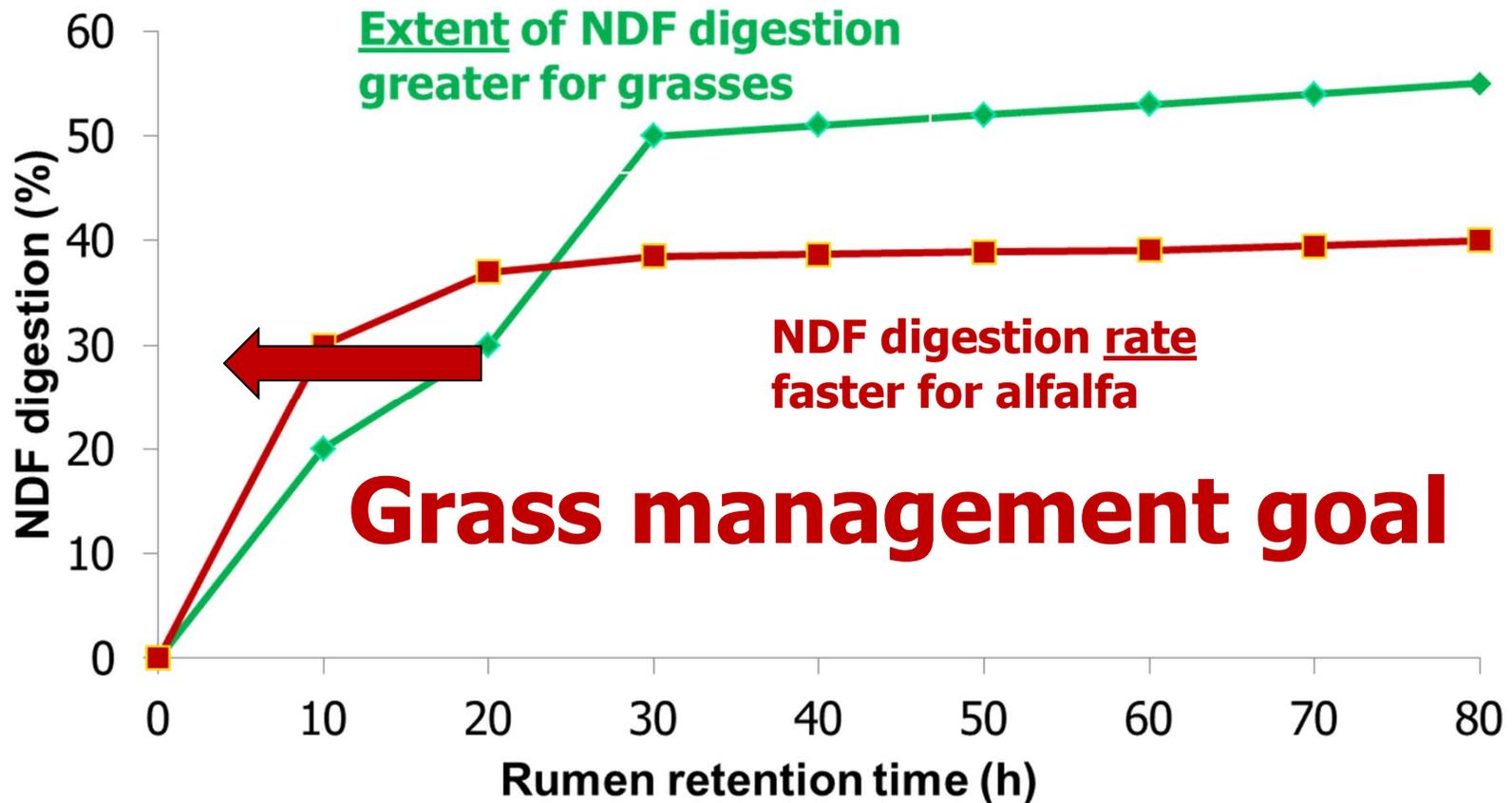
0.90% of BW minimum



How much NDF can be consumed?

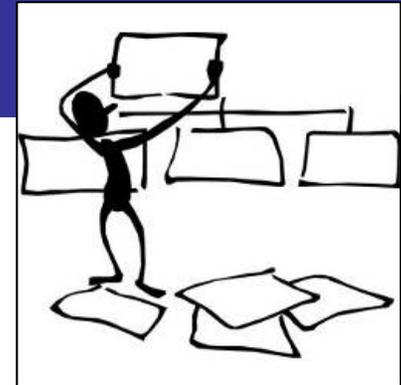
- **1.10% of body weight**
 - **1.53% with high-bmr corn silage**
 - **1.80% with pasture**
 - **Grass vs legume**
-
- **We've underestimated the Intake Potential of forage-NDF**

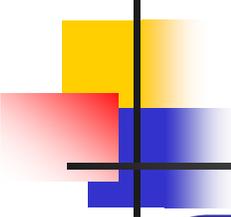
Grass versus legume digestion in the rumen



**Response to forage
digestibility varies by
milk production level.**

So target its use!





Forage Digestible NDF and Performance (Oba and Allen, 1999)

**For every 1
percentage-
unit increase
in NDF
digestibility**

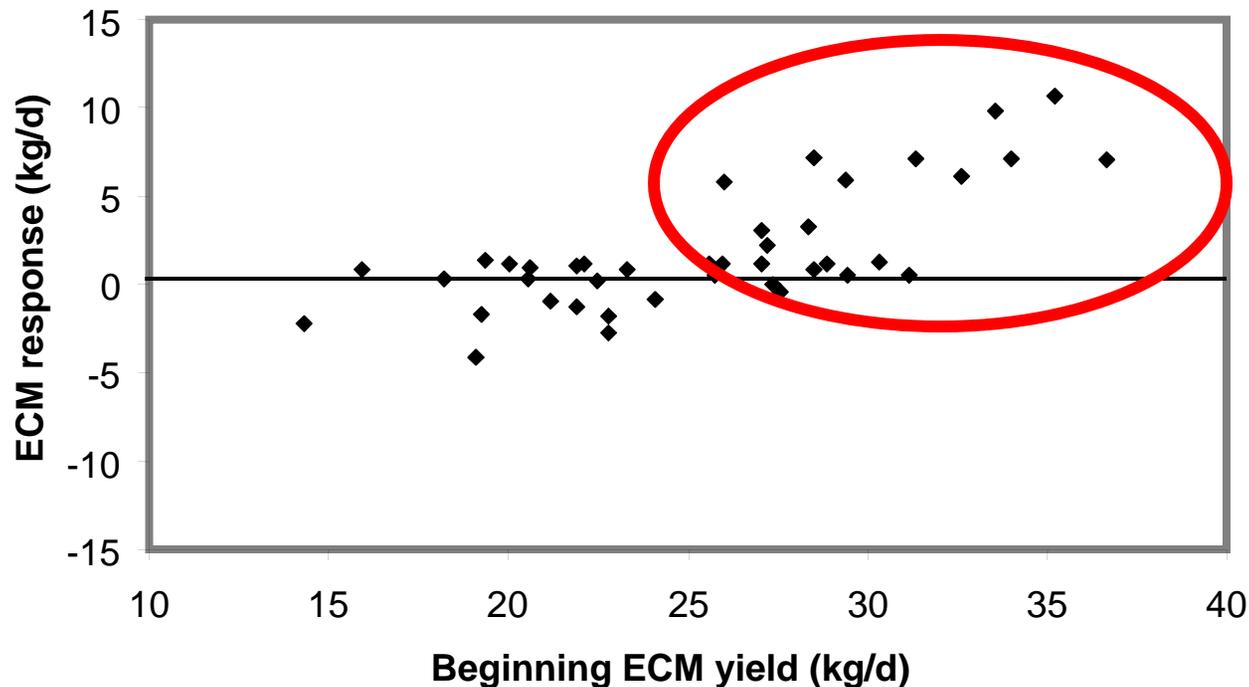
- **+0.40 lb/d DMI**
- **+0.53 lb/d milk**
- **+0.55 lb/d 4%FCM**

**>40% corn
silage in diet**

- **+0.26 lb/d DMI**
- **+0.31 lb/d 3.5%FCM**
(Jung et al., 2010)

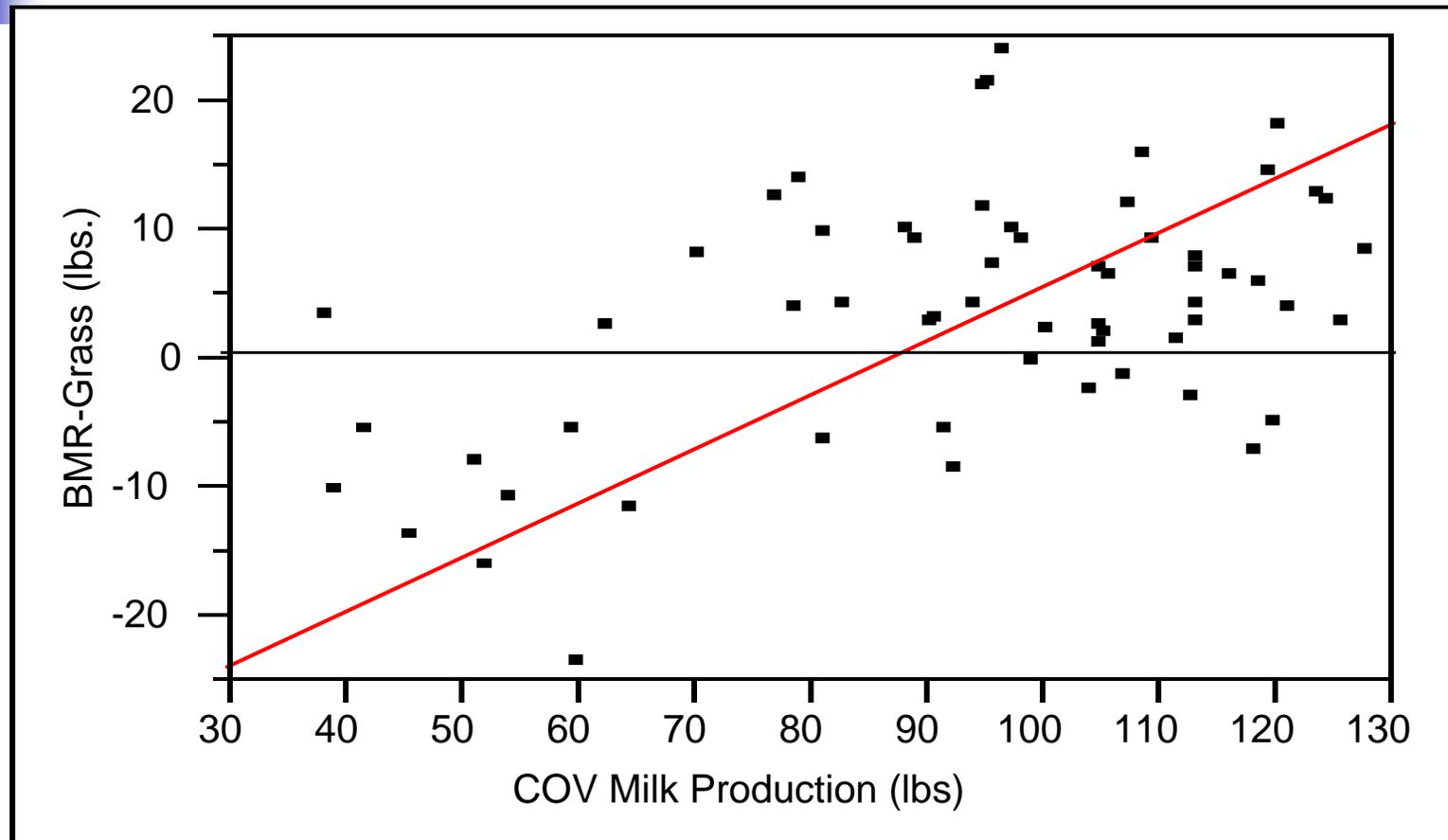
Response to High-NDFd Corn Silage by Milk Production Level

(Ivan et al., 2004)

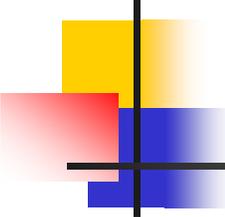


- Allocate high NDFd forages to highest producing cows and fresh cows

Milk production level and response to bmr (24-h NDFD 56%) VS grass (24-h NDFD 53%; Miner Inst., unpublished)



➤ Mycogen F2F444 and 1st cut grass silage (ADF=32.5, NDF=51.1, CP=17.6%)



Physically Effective NDF

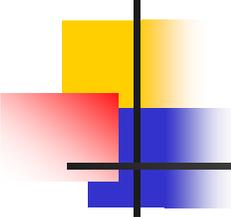
**Fraction
of NDF
that...**

- **stimulates chewing**
- **contributes to rumen digesta mat formation and consistency**

Physical Effectiveness Factor (pef) and peNDF: A Quick Review

- pef = physical effectiveness factor
 - 1.18-mm screen with dry sieving
 - 3.18- or 4.76-mm sieve on farm
 - New PSPS has 4.0-mm sieve (NASCO)
 - Ranges from 0 to 1.0
- peNDF = pef x NDF%





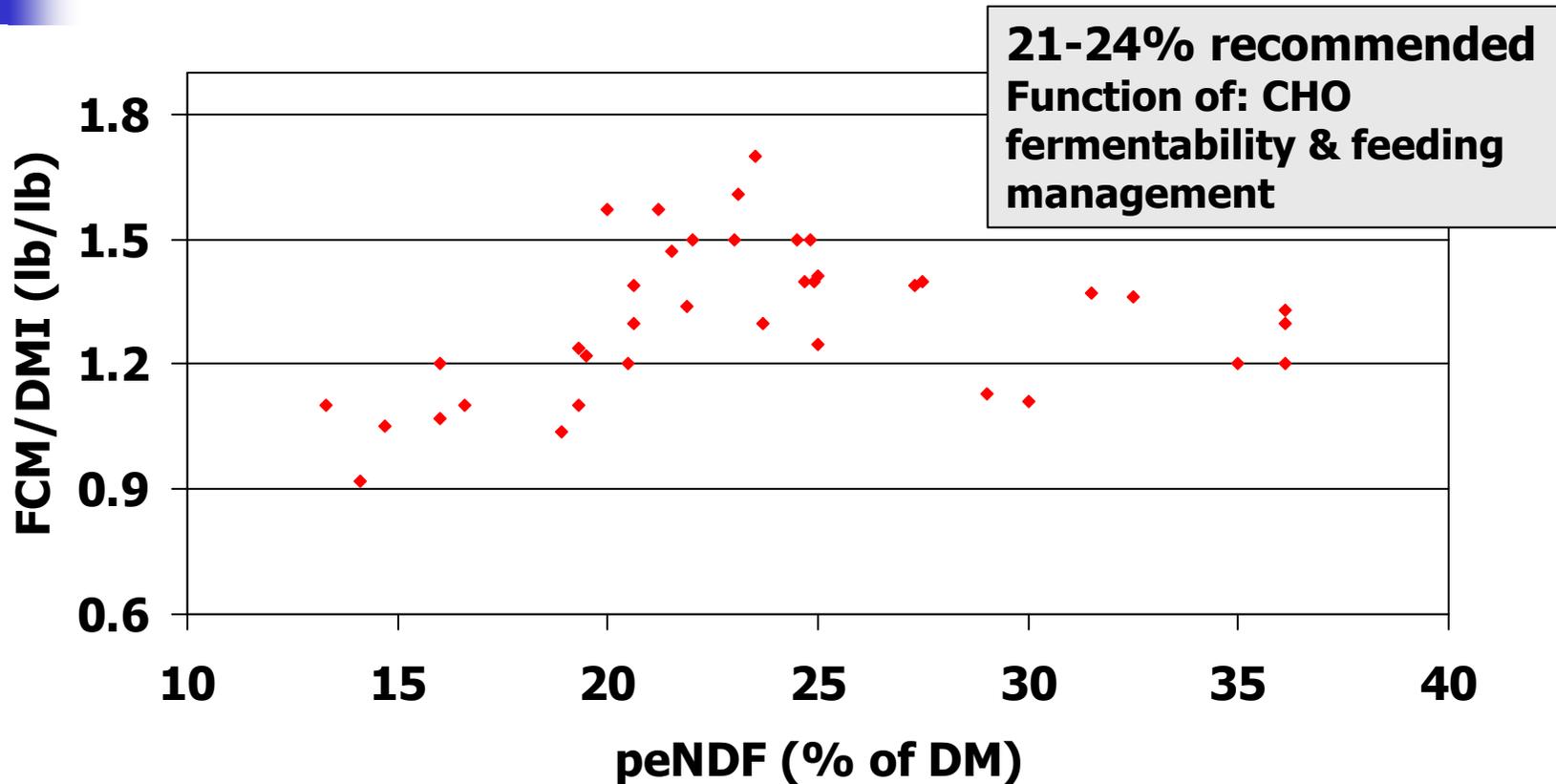
Physical effectiveness factor (%) measured by chewing versus sieving

| Technique | Coarse | Medium | Fine |
|-------------------------|--------|--------|------|
| Lab dry sieving 1.18-mm | 63.3 | 59.9 | 55.0 |
| On-farm as-fed 3.18-mm | 61.0 | 58.0 | 56.0 |
| Cow chewing response | 65.4 | 57.0 | 53.7 |

- **Cow is the ultimate measure of effectiveness!**
- **Chewing response = sieving measurement of physical effectiveness**

Physically effective fiber and FCM/DMI

(Grant, 2008, unpublished)



➤ 12 studies using vertical dry sieving (standard procedure)

PSPS Particle Distribution Recommendations (DM basis)

| Screen (mm) | Corn silage | Haylage | TMR |
|-------------|-------------|---------|-------|
| >19.0 | 5±3 | 15±5 | 5±3 |
| 19-8.0 | 55±10 | 60±15 | 40±10 |
| 8.0-1.18 | 40±10 | 30±10 | 40±10 |
| Pan | <5 | <5 | ≤20 |

(Kononoff, 2004)

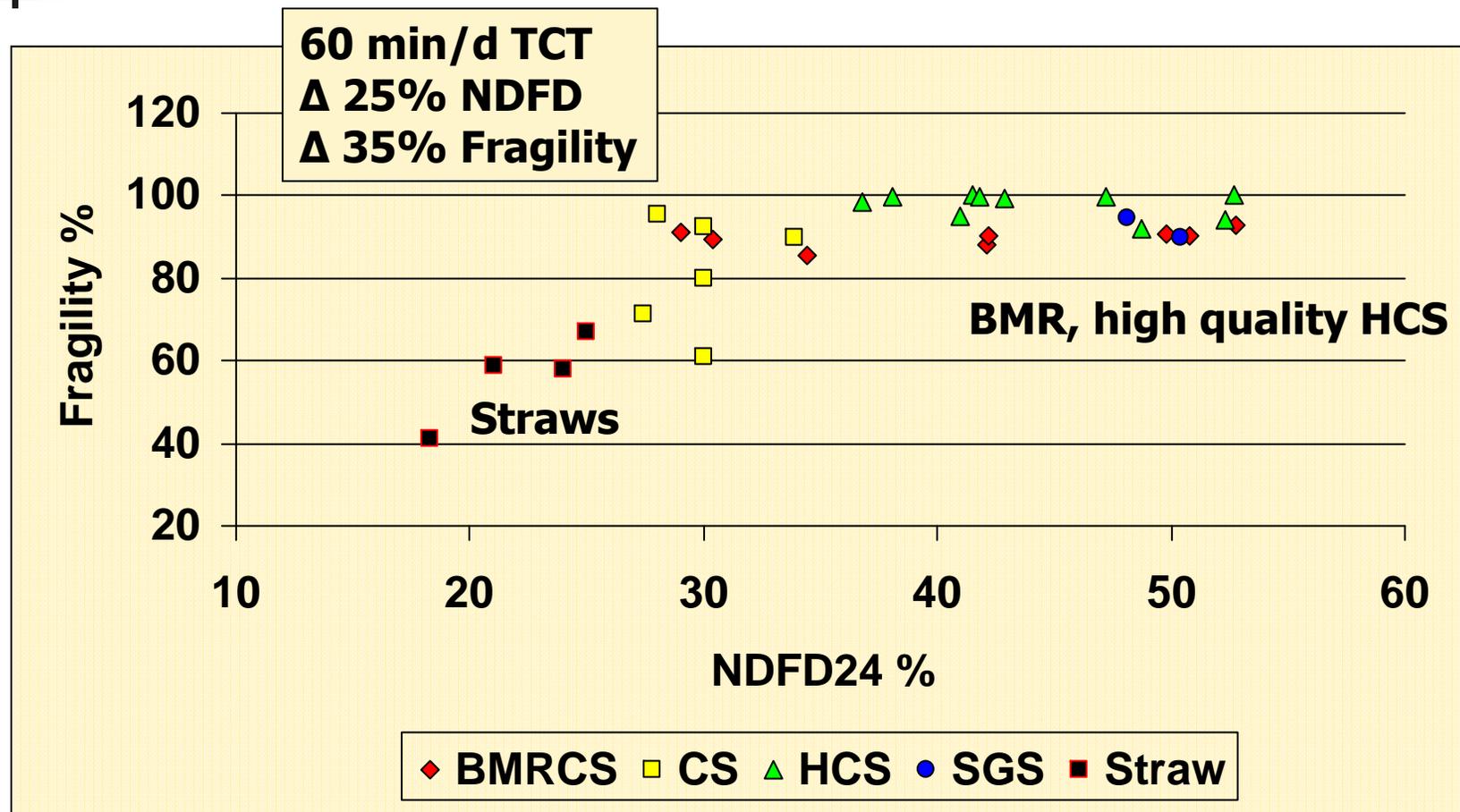


➤ Assesses chop length, TMR size distribution, sorting

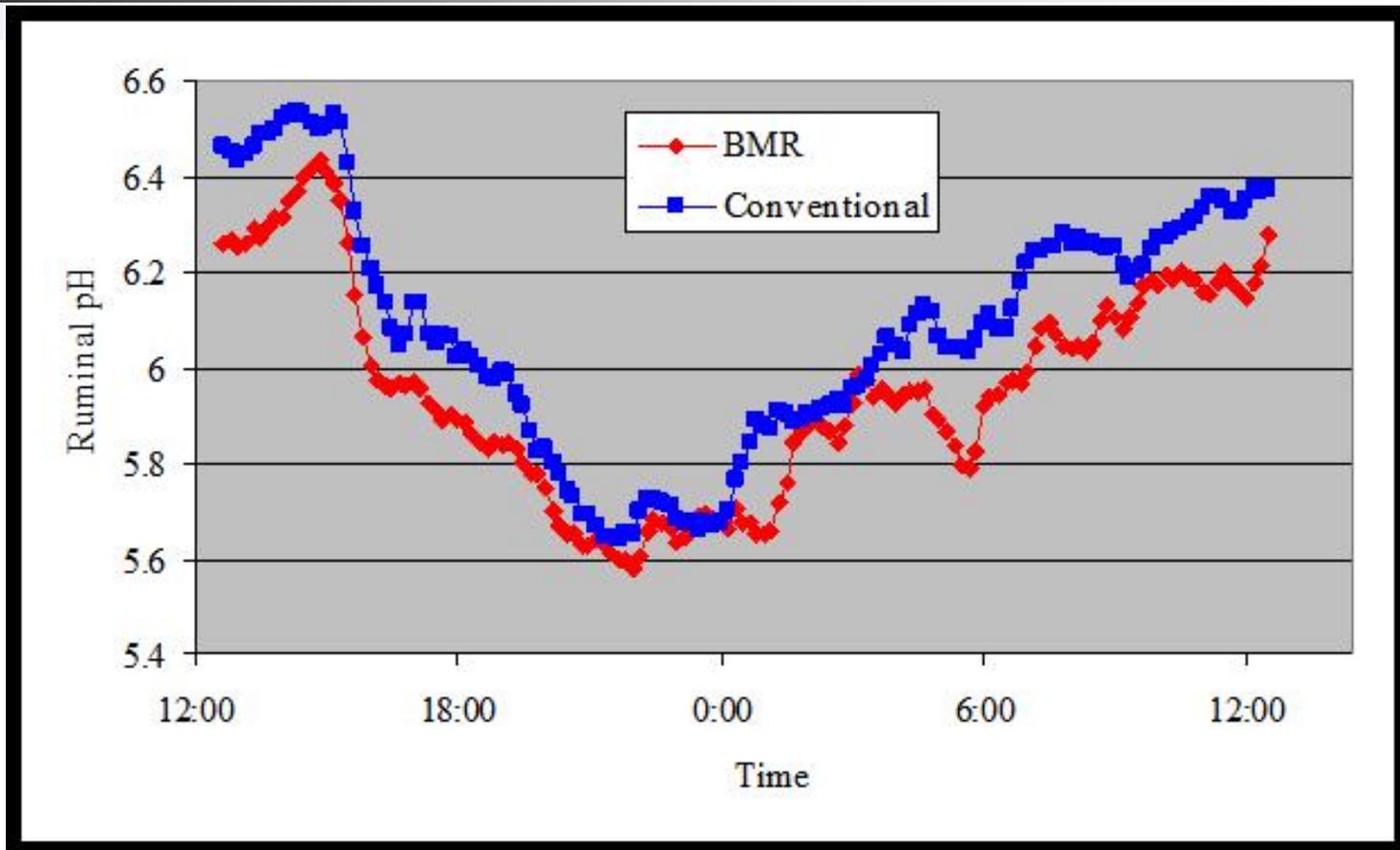
Size isn't everything

Greater fiber digestibility enhances forage fragility

(Cotanch et al., 2008)



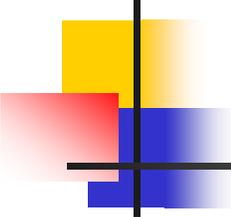
Rumen pH for cows fed bmr or conventional corn silages in TMR



➤ Particle size does not tell entire story!



Cow Management Environment?



When Forage NDF Digestibility and peNDF are in Balance ...

- Higher rumen pH and fibrolytic bacteria
- Greater microbial protein production
- Improved milk components
- DMI & milk yield increase
- Peak milk & persistency increase
- SCM/DMI increases
- Less body weight loss in early lactation
- Better body condition & better reproduction
- **Profit increases!**

Thank You

