6.5 Biology

Everything you Need to Know

Winter 2015

What is it ?

Primarily changes in feed analyses and digestibility rate calculation formulas

Paving the way for the next BIG change—CNCPS 7.0

Carbohydrate Analysis Changes

It’s all about NDF

The Alphabet Soup

a NDF om

aNDFom

Cleans up the "contaminates" that skew the NDF analysis results

aNDFom—Nitrogen and starch contamination

- removed by treatment with sodium sulfite and amylase

aNDFom—Ash contamination

- firing post-boiling to subtract out dirt, non-organic particles

Source of Ash Contamination

- Modern Methods of Hay making
  - Big equipment makes lots of dust
- Flood Irrigation
- Soil and dirt does not solubilize in NDF solution and if not corrected for will inflate values


CLAAS

27 FIELD 316 SORGHUM X SUDAN

FIBER	% NDF	% DM
ADF	56.5	34.0
aNDF	→	60.2
aNDFom	→	55.4
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	4.95	2.98
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)	60.2	36.3
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)	74.9	45.1
uNDF (30 hr)	39.8	24.0
uNDF (240 hr)	25.1	15.1

~ 5 units

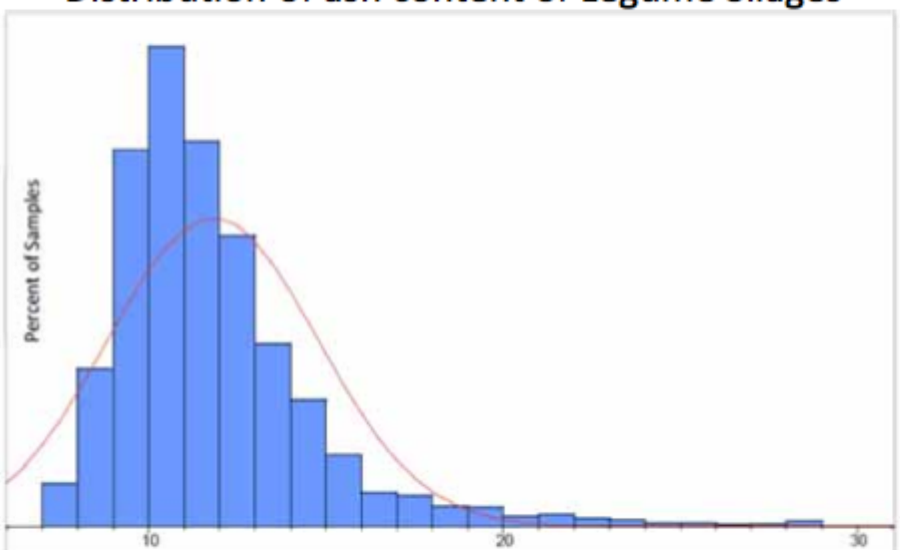
26 FIELD 308 TEST 2 SORGHUM X SUDAN

FIBER	% NDF	% DM
ADF	57.6	36.8
aNDF	→	63.9
aNDFom	→	53.7
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	4.86	3.11
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)	49.3	31.5
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)	77.0	49.2
uNDF (30 hr)	50.7	32.4
uNDF (240 hr)	23.0	14.7

10 units

Legume Silage Example

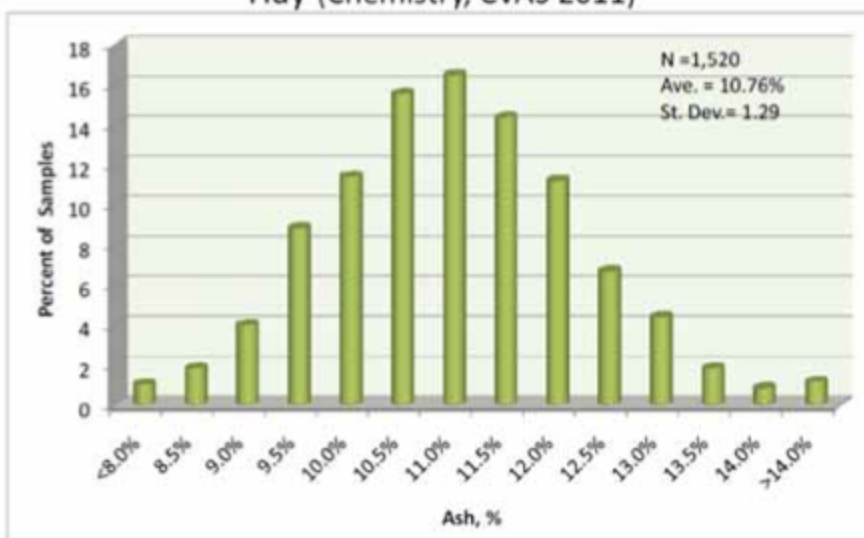
Distribution of ash content of Legume Silages



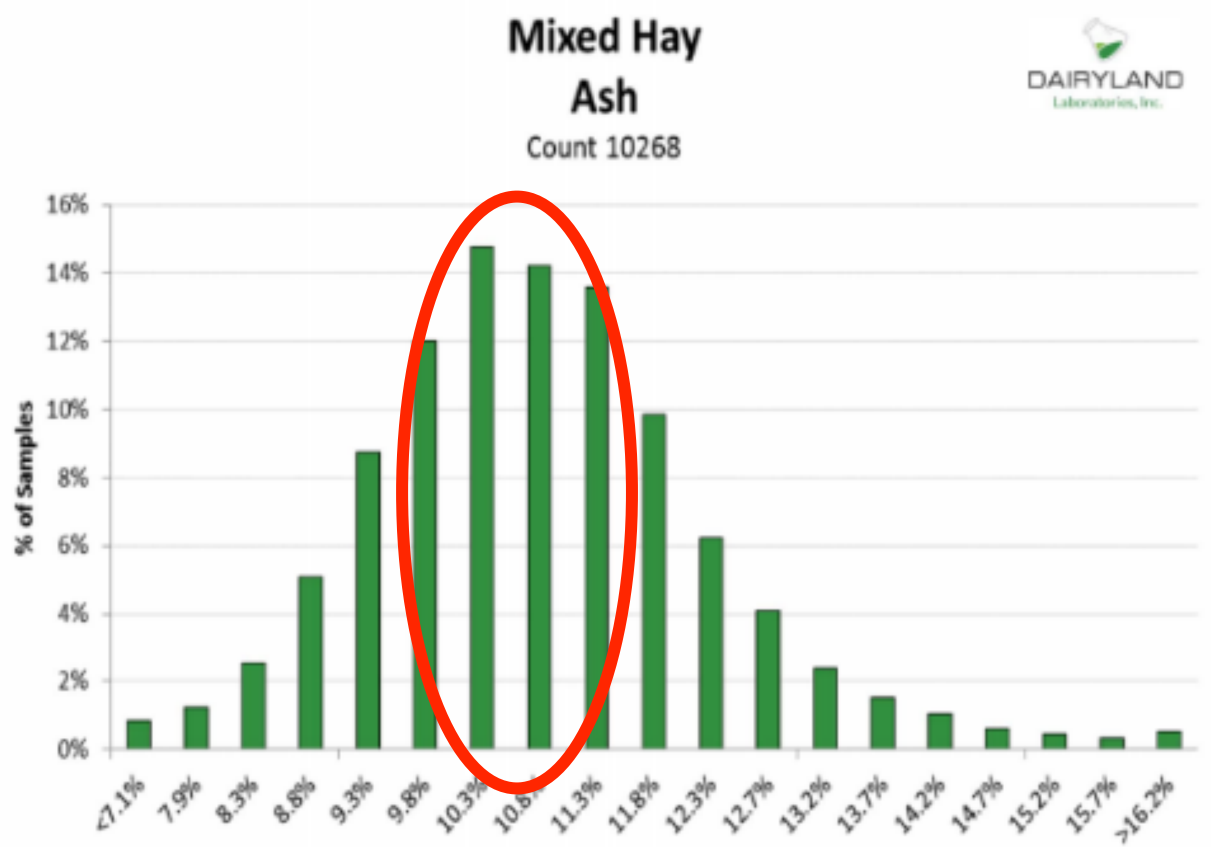
Ralph Ward, CVAS

Alfalfa Hay Example

Figure 14. Distribution of Ash, Western States Alfalfa Hay (Chemistry, CVAS 2011)

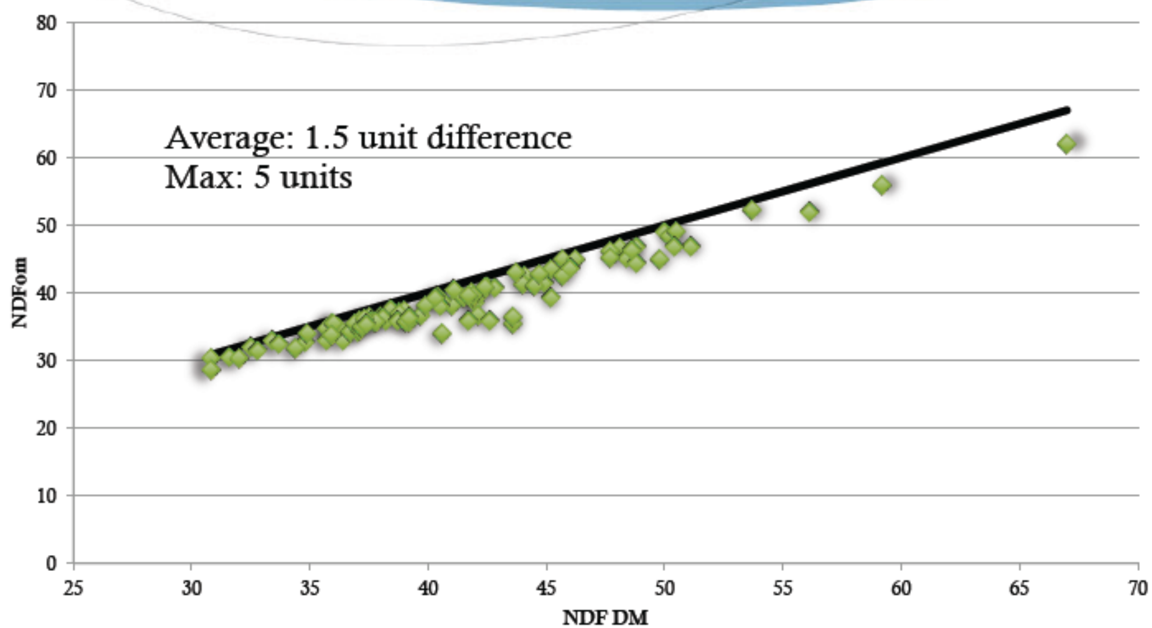


Ralph Ward, CVAS



Mixed Hay
Ash
Count 10268
DAIRYLAND
Laboratories, Inc.
% of Samples
16%
14%
12%
10%
8%
6%
4%
2%
0%
<7.1%
7.9%
8.3%
8.8%
9.3%
9.8%
10.3%
11.3%
11.8%
12.3%
12.7%
13.2%
13.7%
14.2%
14.7%
15.2%
15.7%
>16.2%

Alfalfa hay/haylage aNDFom



Bottomline

NDF content of diets, in some cases, will DROP 2-5 units

On specific raw materials

Irrigated crops

farms with large equipment

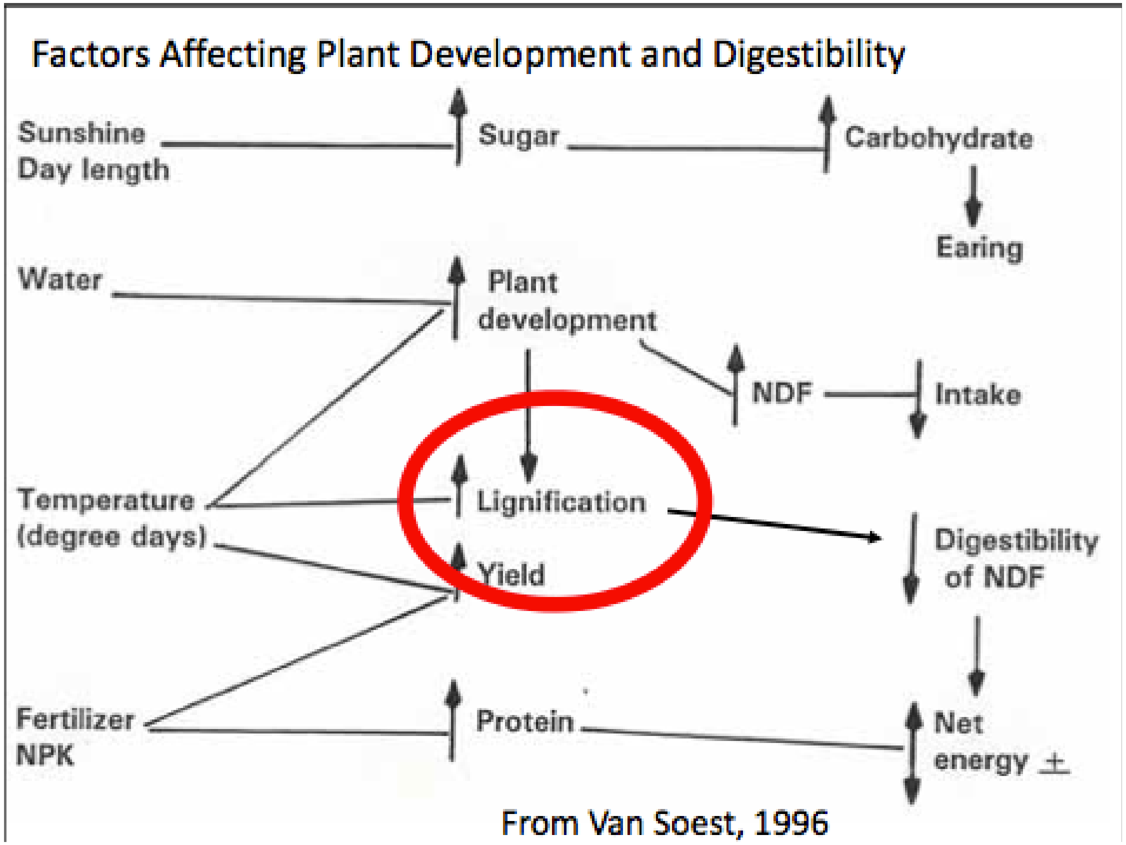
May see as high as a 10 point drop!

a NDFom

To Lignin or Not to Lignin

- Lignin itself does NOT correlate well with NDF digestibility
  - It is all about the cross-linkages between lignin and hemicellulose and cellulose that dictate digestibility
- There will no longer be a need to determine lignin!
  - Makes labs happy as NIR calibrations for lignin are difficult.

NDF—Relations to Digestibility



Lignin is not Lignin is not Lignin

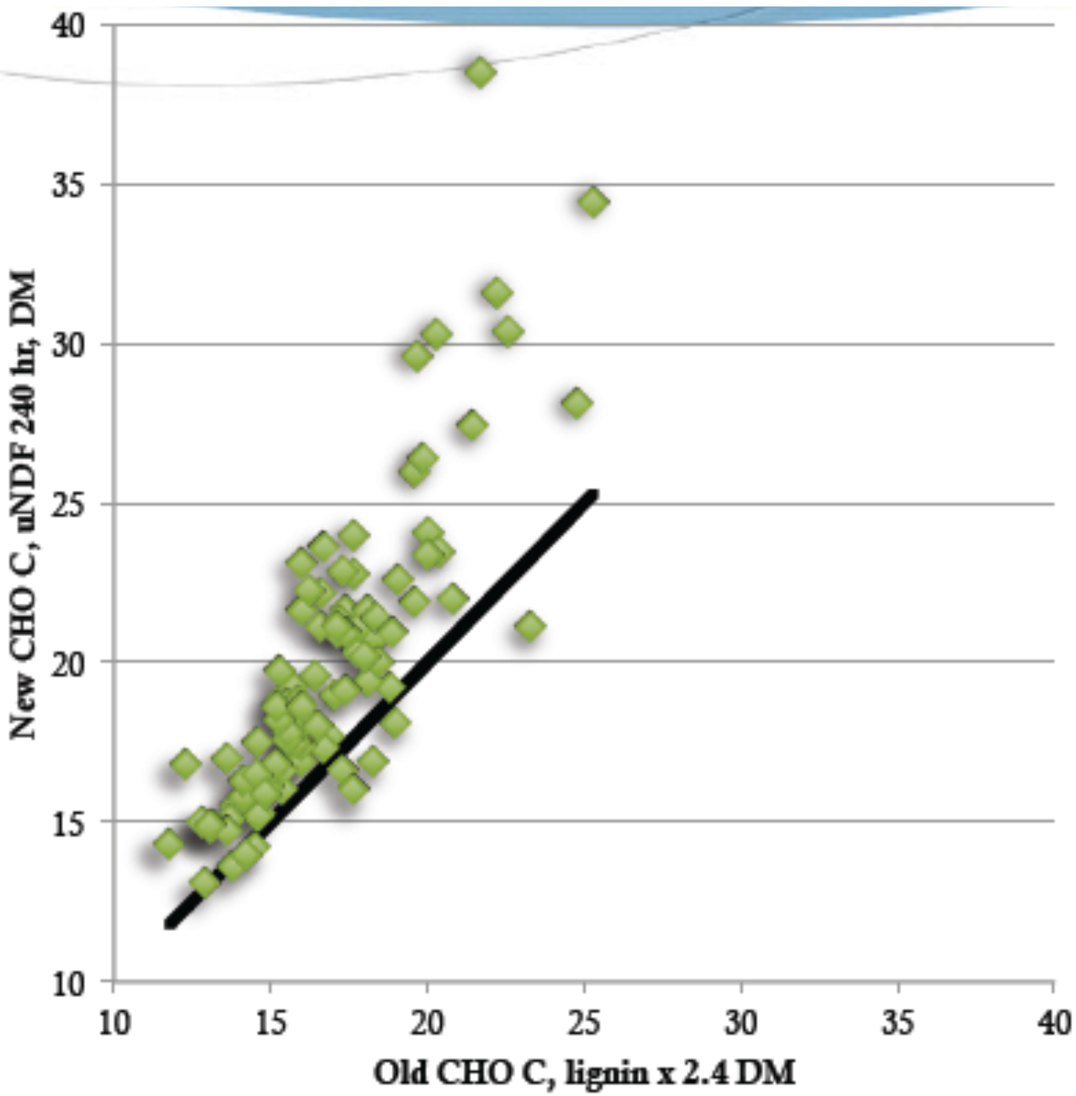
2.4 factor to calculate CHO C is NOT constant

- BMR corn silage hybrids, **3 to 5**
- Conventional hybrids **2 to 7**
- Alfalfa **1.9 to 3.2**

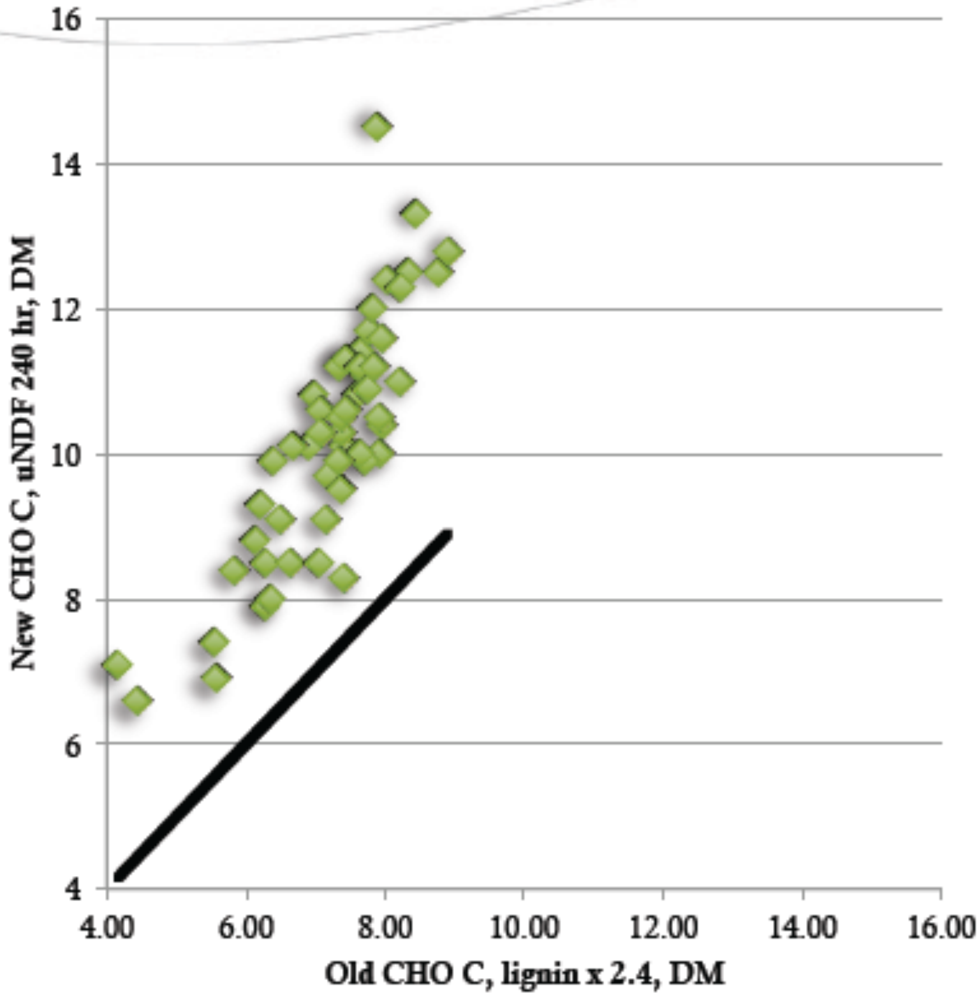
  (with 80% between **2.2 and 2.8**)
- Grasses **1.5 to 5.5**

  (with immature grasses varying from **1.9 to 7.5**).

New Data Alfalfa



New Data Corn Silage

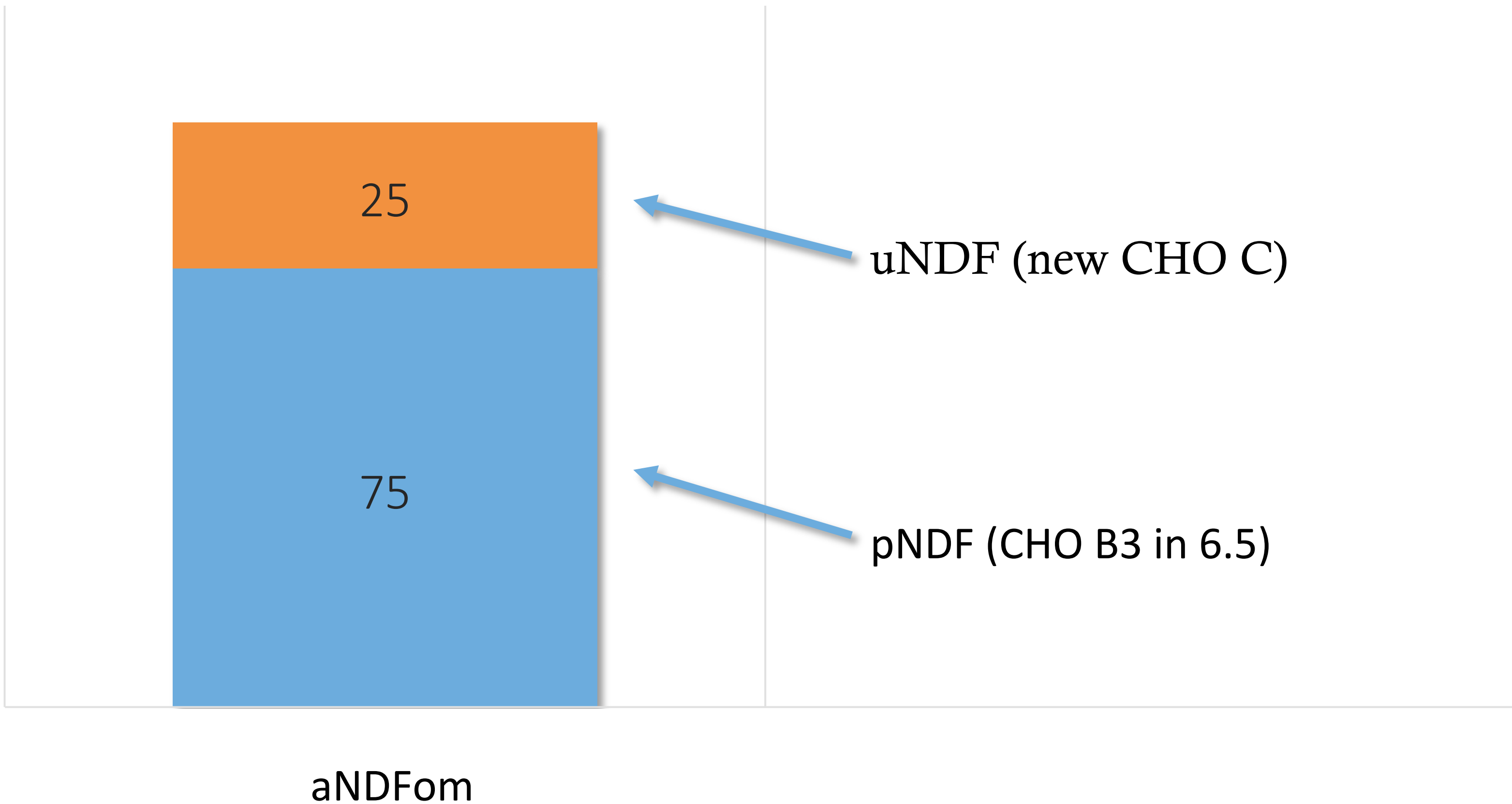


uNDF

Some papers call it iNDF to represent indigestible NDF

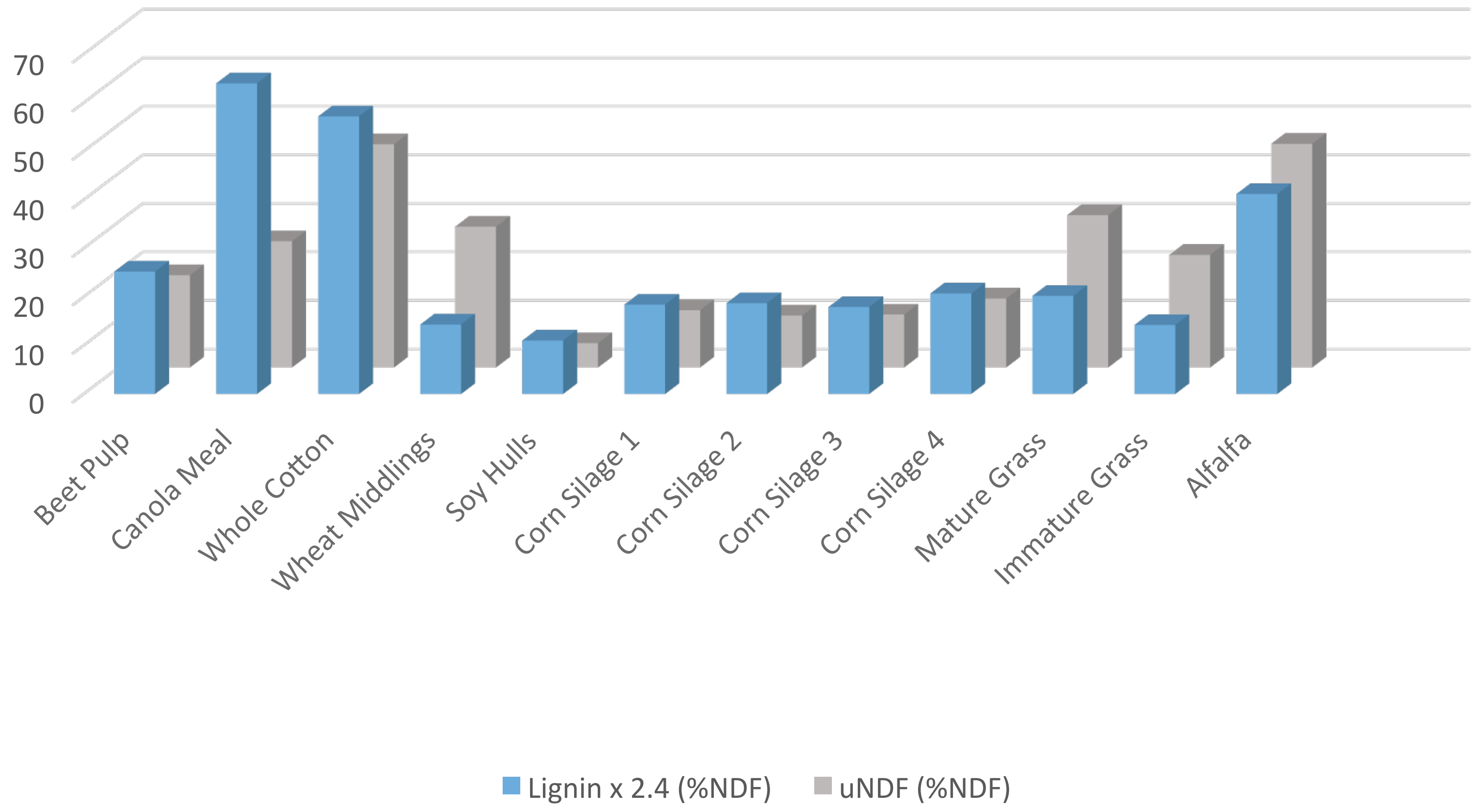
- Mertens has pushed for us to call it uNDF for undigestible NDF and uNDF is becoming the *de facto* standard term

aNDFom – uNDF = pNDF



uNDF is determined with different time points for forages vs. non-forages

uNDF vs Lignin x 2.4 in Select Feeds

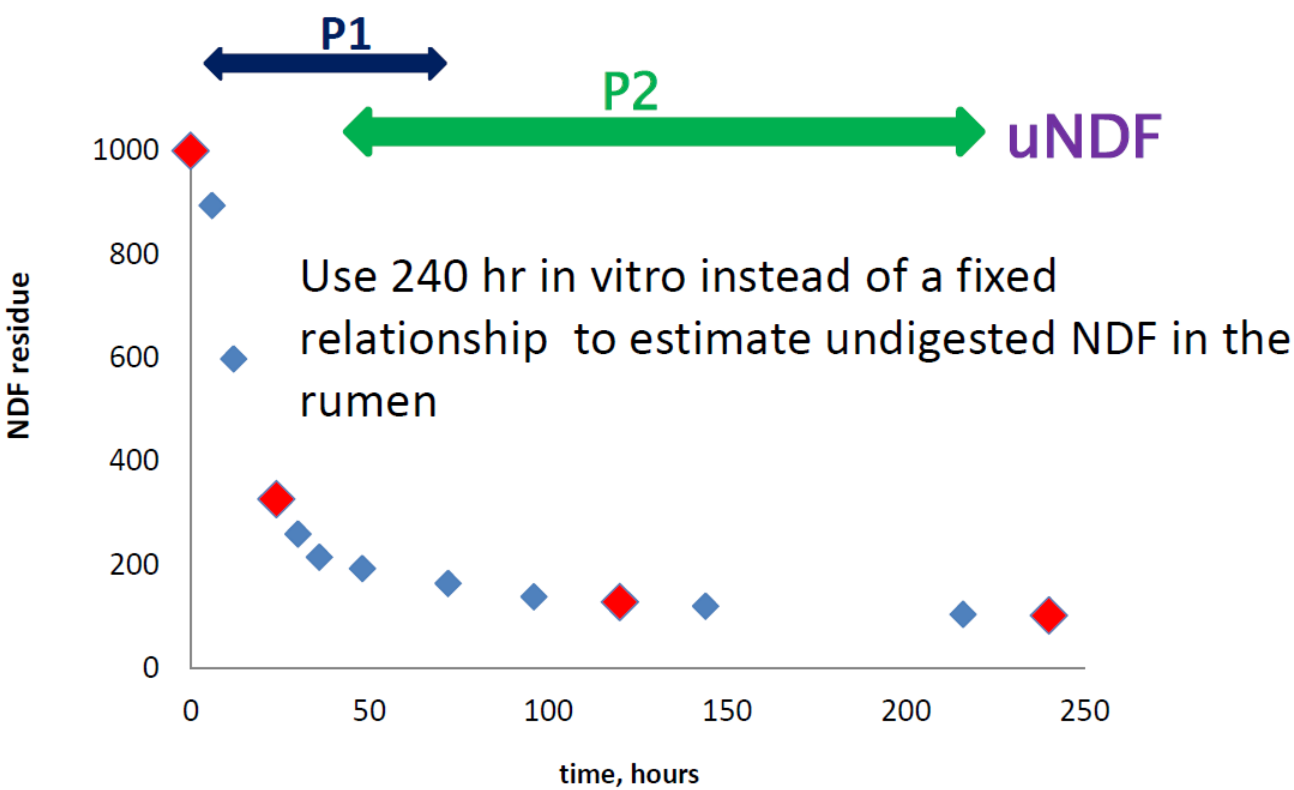


Who's got the time?

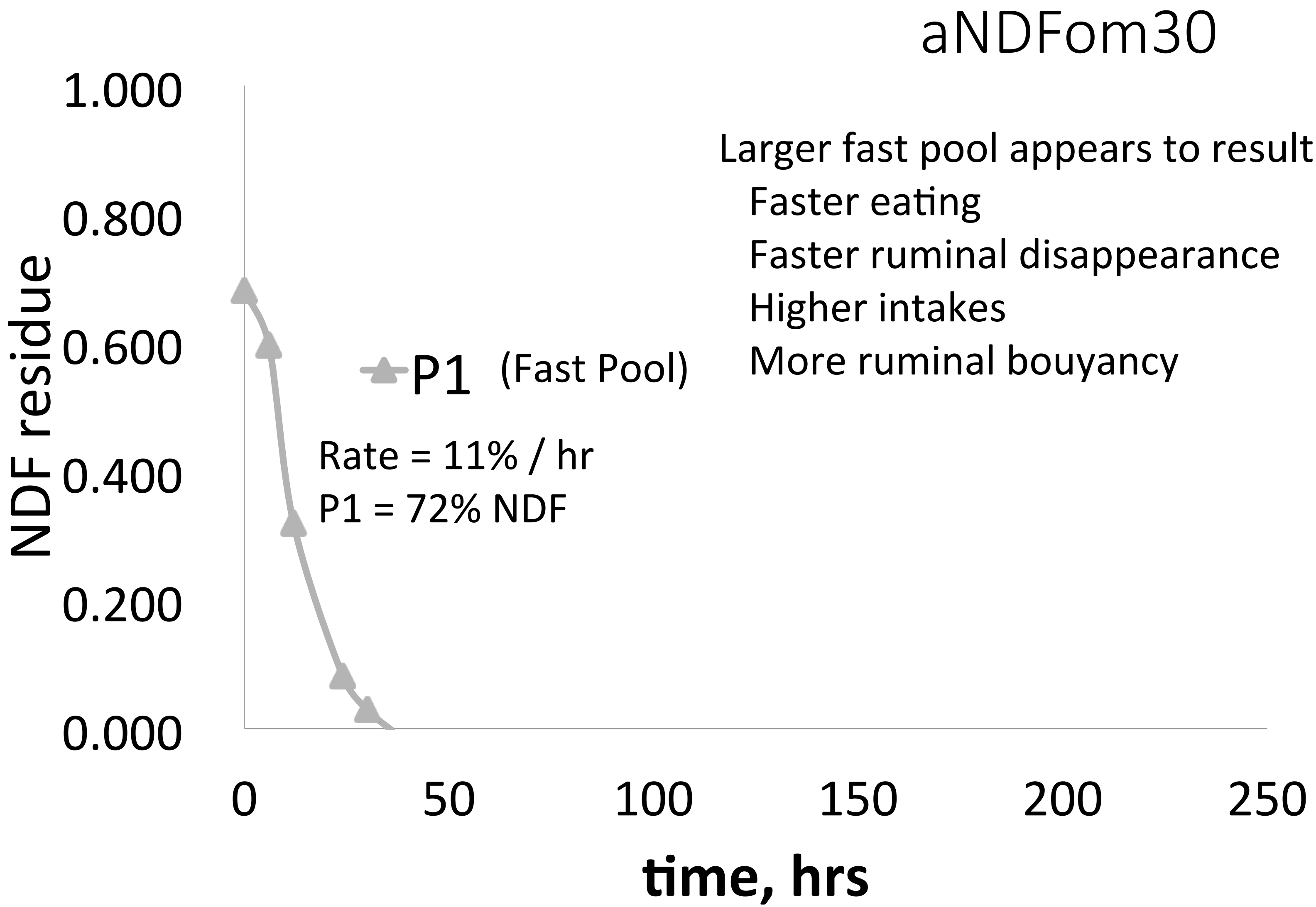
Digestibility values for forages: 30, 120, and 240

Digestibility values for non-forages: 12, 72, and 120

2 time-points + 240 hours



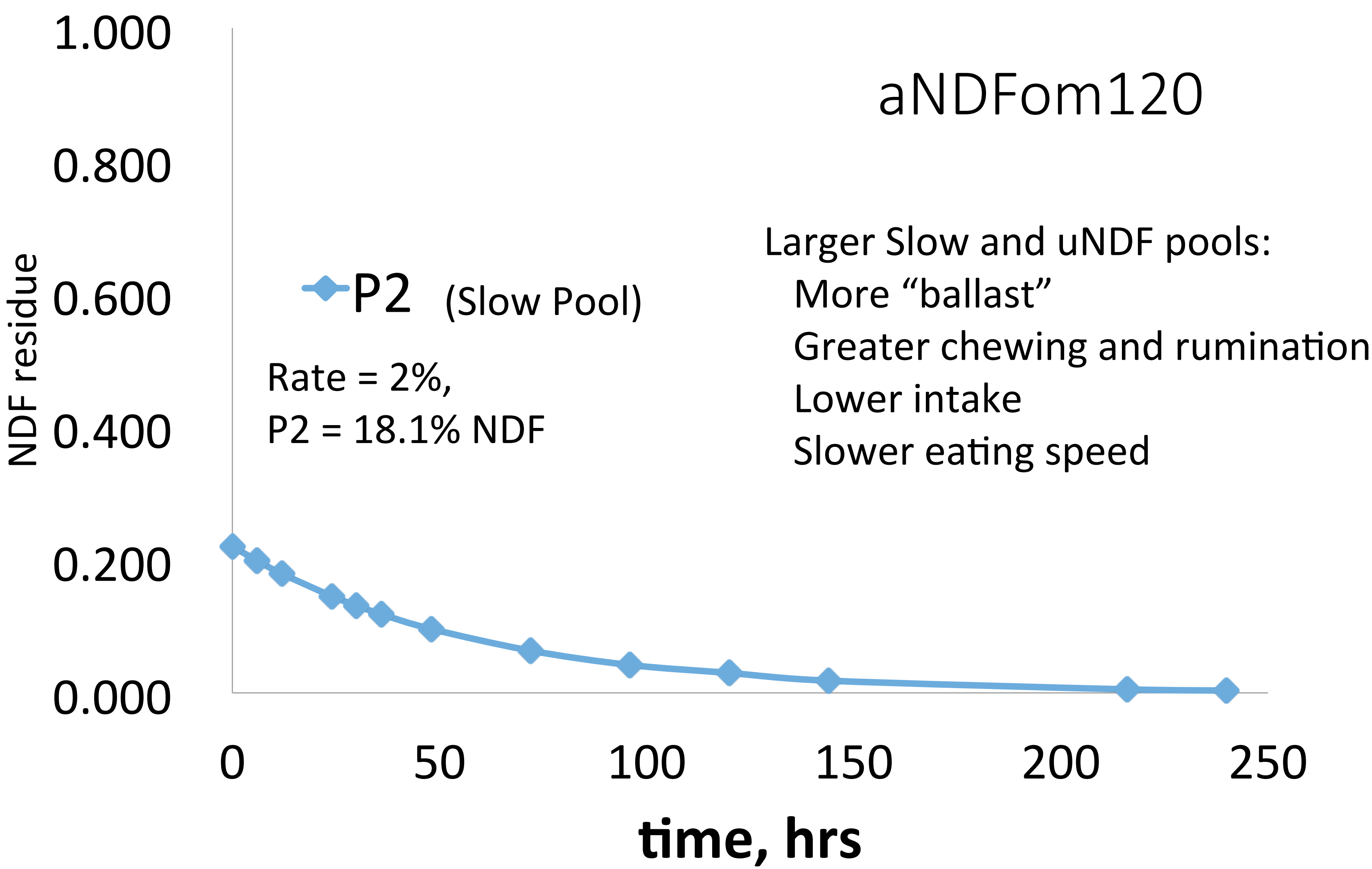
Corn silage example: fast pool



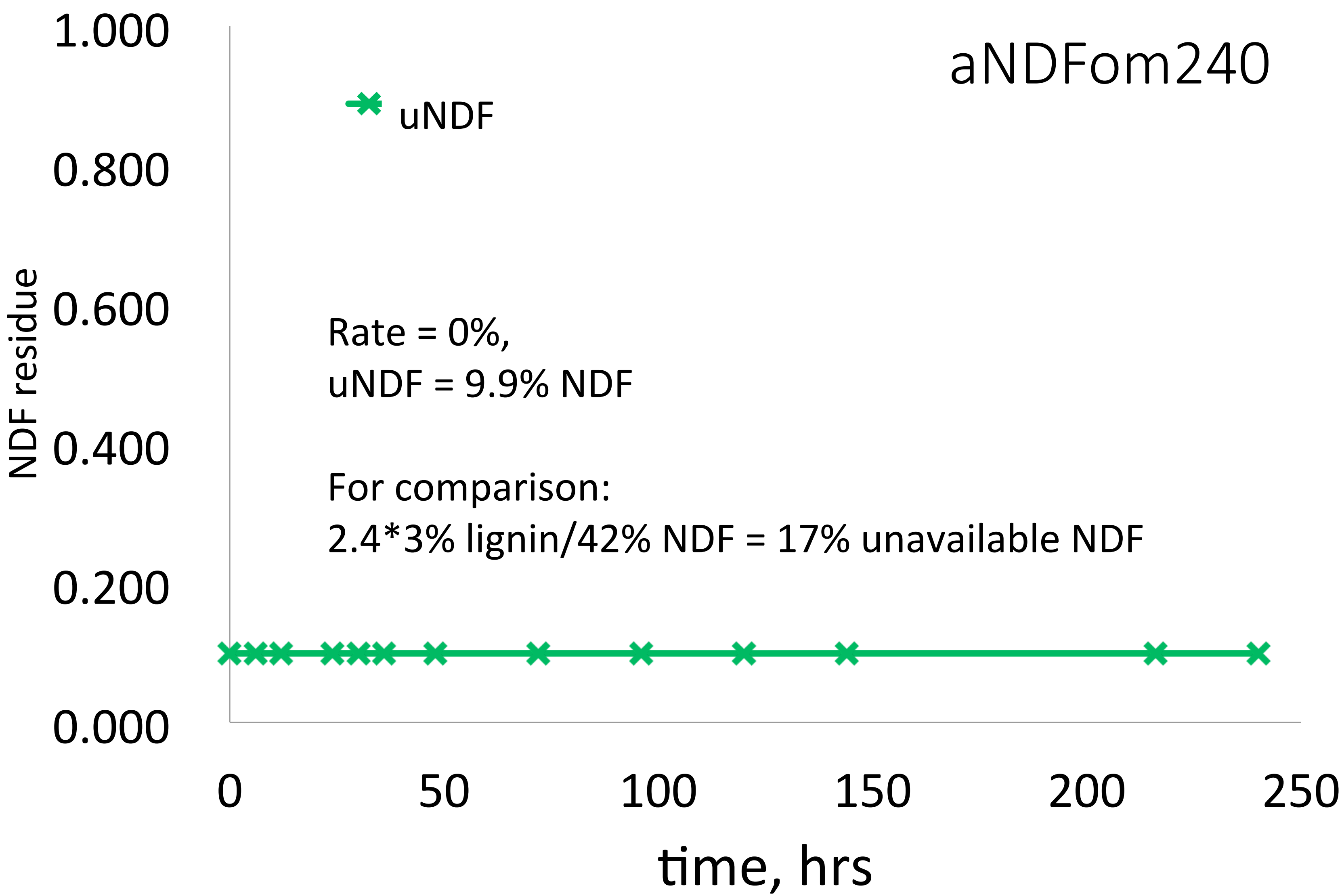
Larger fast pool appears to result in:

- Faster eating
- Faster ruminal disappearance
- Higher intakes
- More ruminal bouyancy

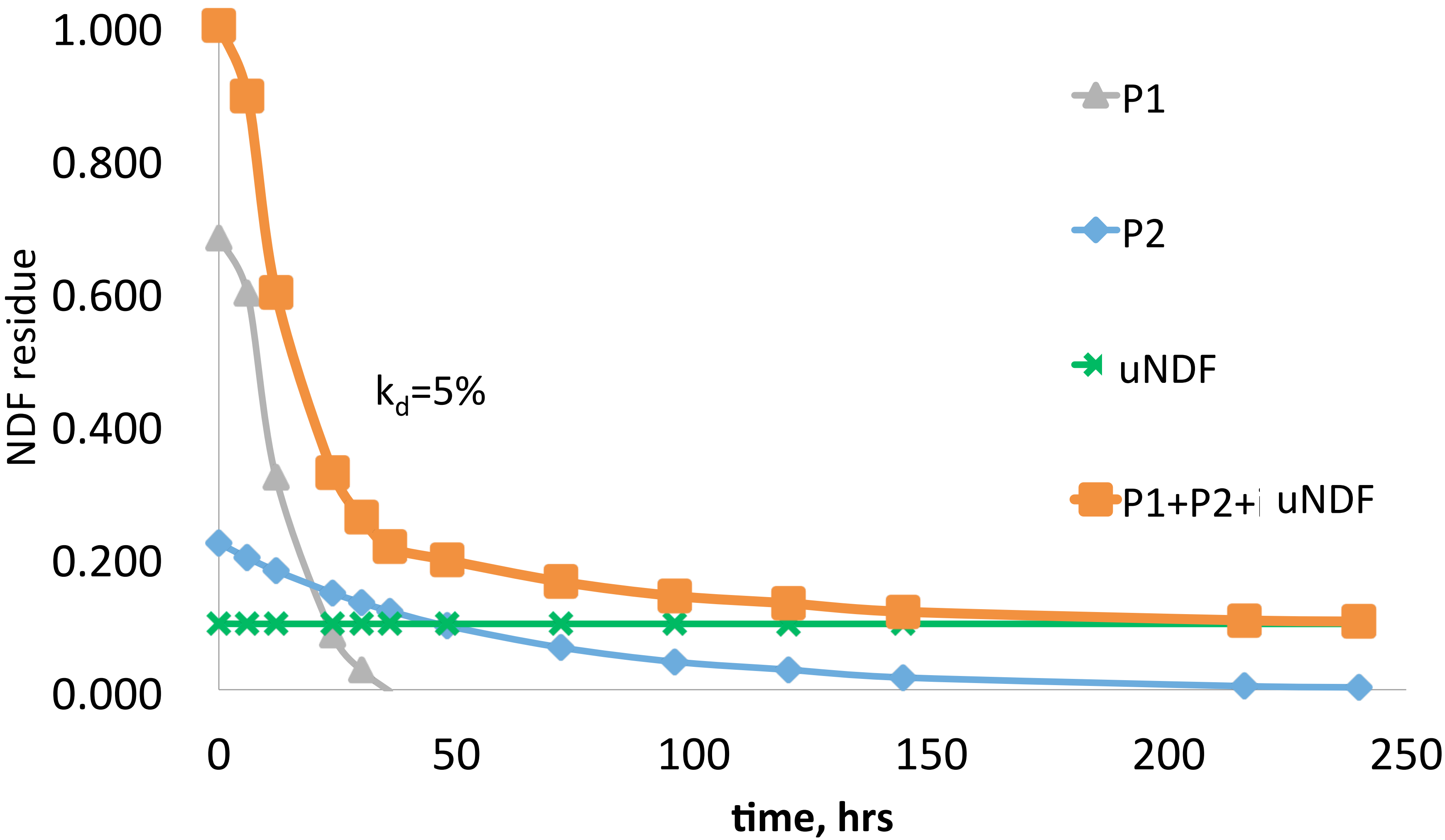
Corn silage example: slow pool



Corn silage example: uNDF



Corn silage example: P1+P2+uNDF



uNDF and intake appear to be very highly correlated

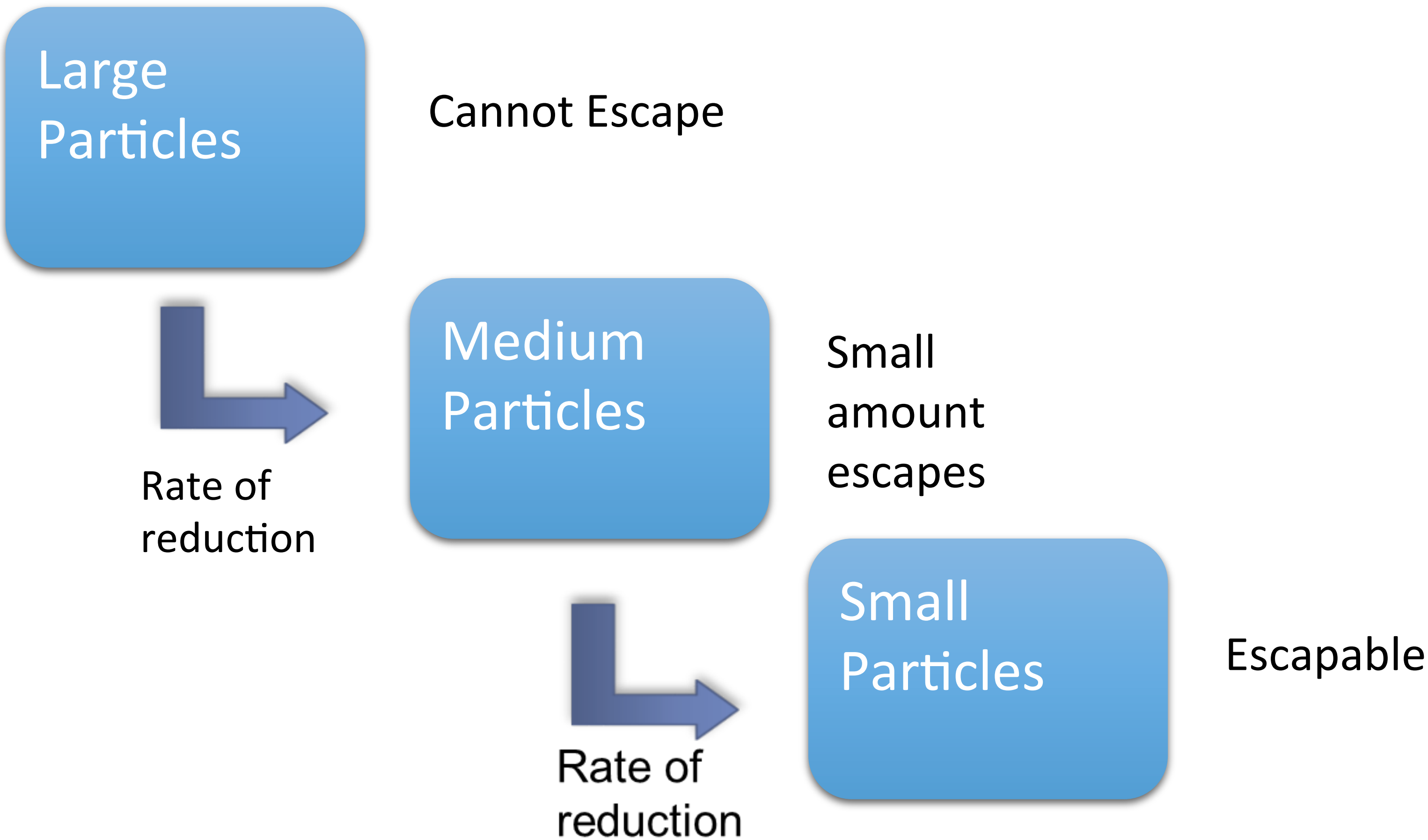
- It appears in Holsteins that the cow will reach a steady-state uNDF rumen level
  4-5 kg or 8.8 to 11 lbs.

For her to consume more feed, an equal amount of uNDF must escape the rumen first.

- uNDF has 0 kd so completely regulated by passage rate

This has massive potential impact on formulation, procurement, and manufacturing thinking.

What can we do to move uNDF along?

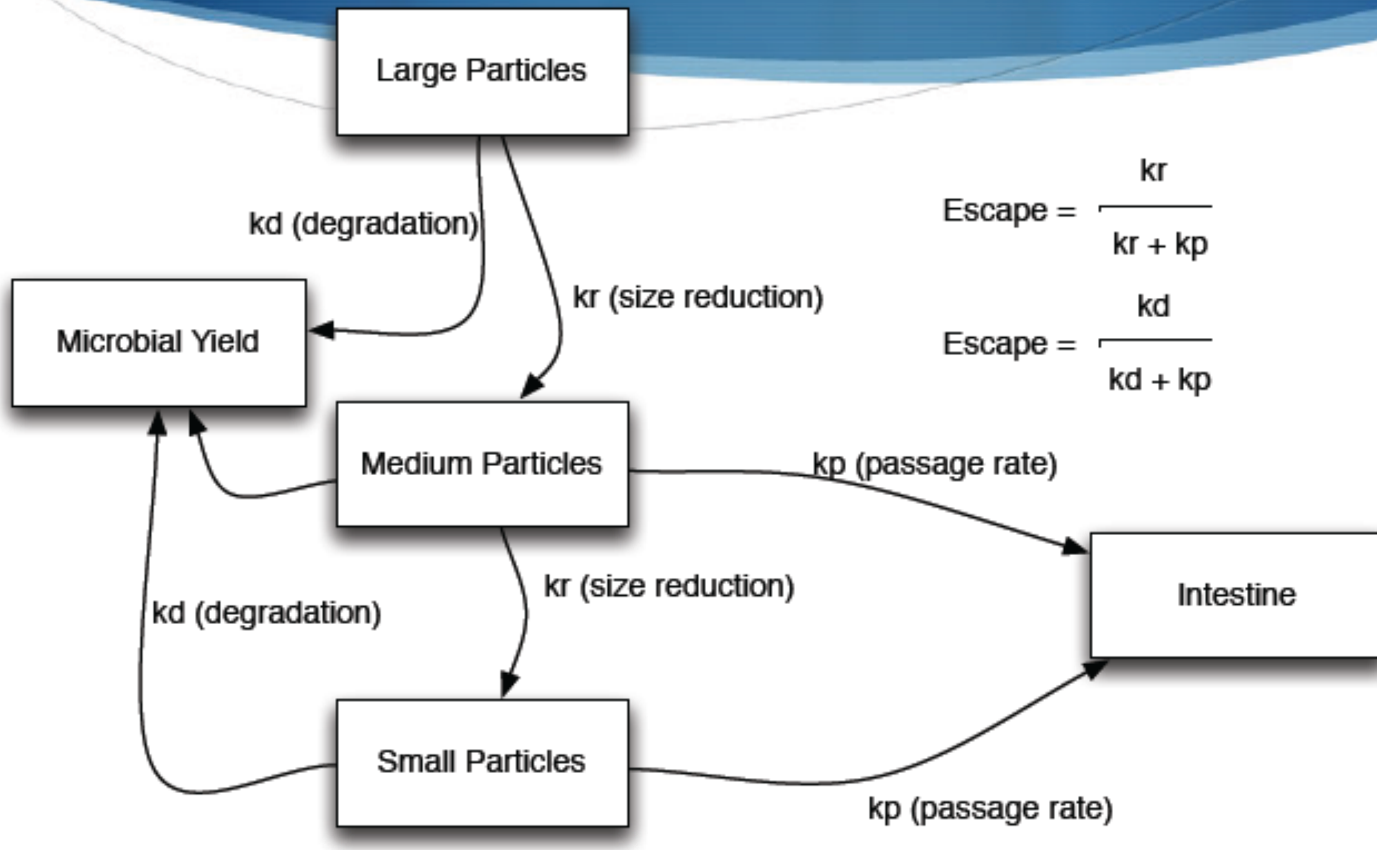


Particle Size

For uNDF to move out of the Rumen, particle size reduction must occur

- In Rumen:
  - Large- No passage rate (kp), no rate of reduction in size (kr), and mostly lowest in density
  - Medium: low kp and still kr
  - Small: kp and highest density

Manufacturing to reduce particle size—Grinding and Pelleting



$$\text{Escape} = \frac{kr}{kr + kp}$$

$$\text{Escape} = \frac{kd}{kd + kp}$$

So we have two competitive functions impacting escape

Who's got the time?

Digestibility values for forages: 30, 120, and 240

Digestibility values for non-forages: 12, 72, and 120

Non-Forage NDF

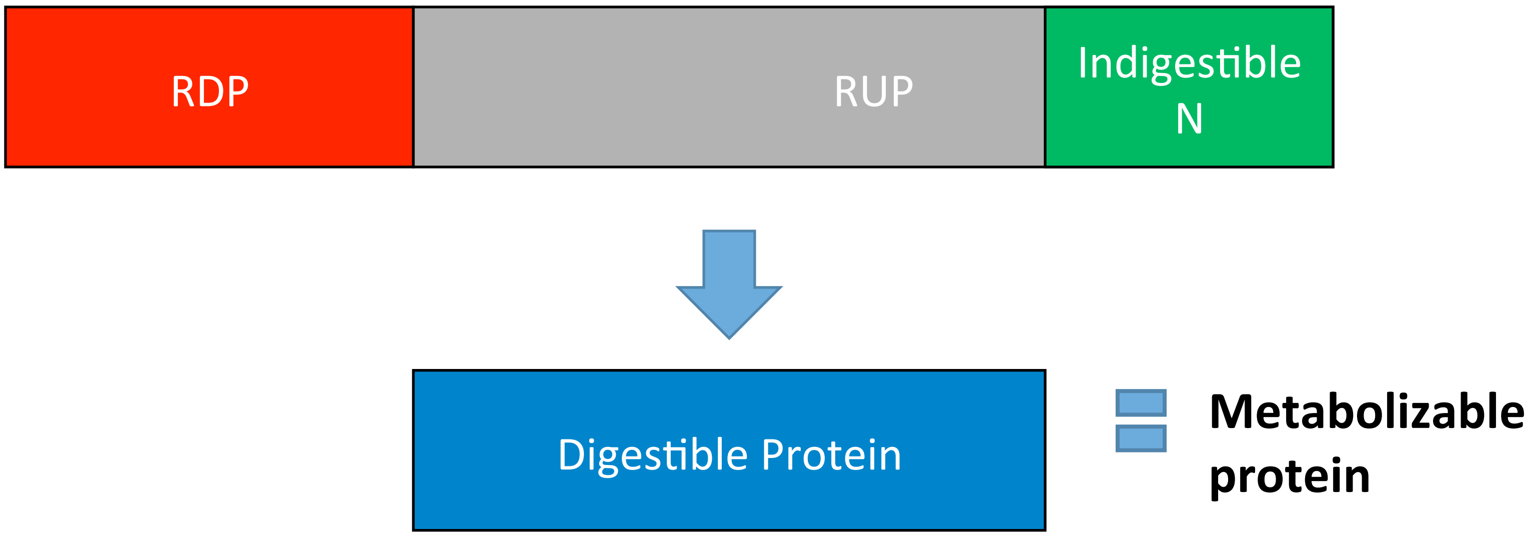
- uNDF value determined at 120 hours
- 12 hrs– the fast pool time point is the most challenging for labs from a scheduling basis
- 72 hours—Slow pool

Many non-forage fiber sources show a two pool degradation rate relationship

Nitrogen Analysis Changes

Ross uN system

No more ADIN



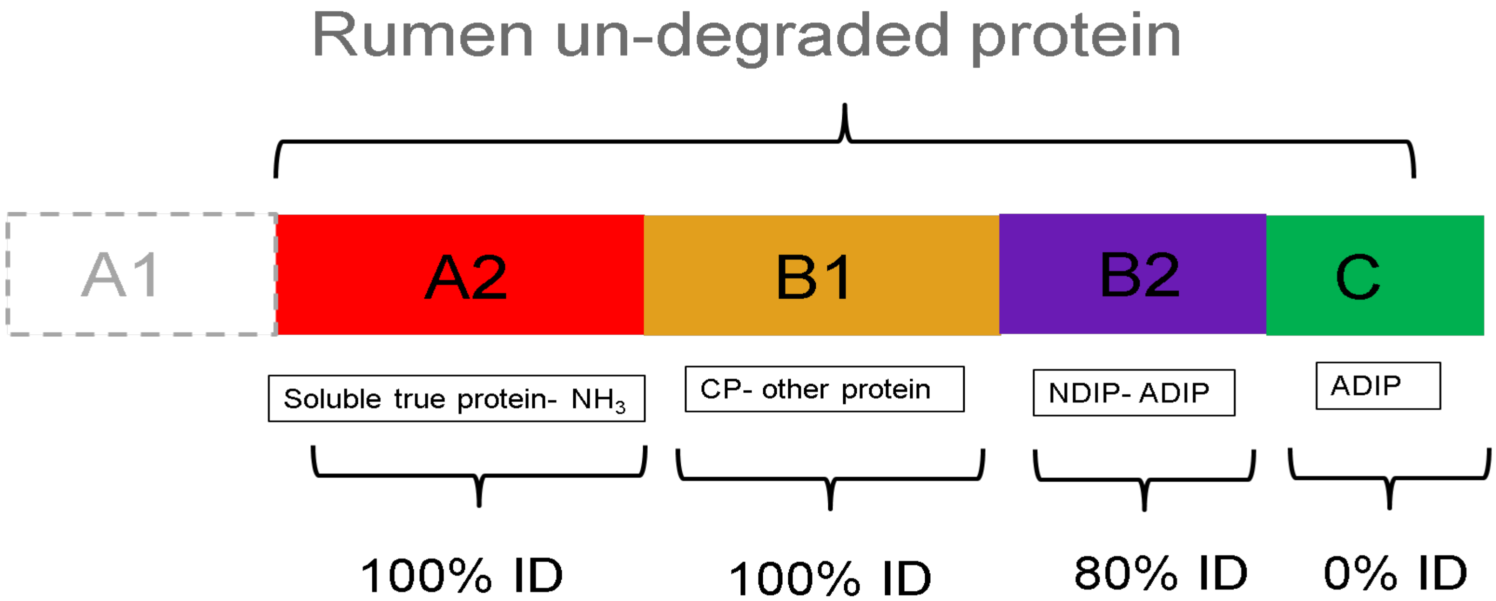
Intestinal digestibility = 1 – [indigestible N/ rumen un-degraded protein]

uNRoss Assay for Determining Nitrogen Digestibility

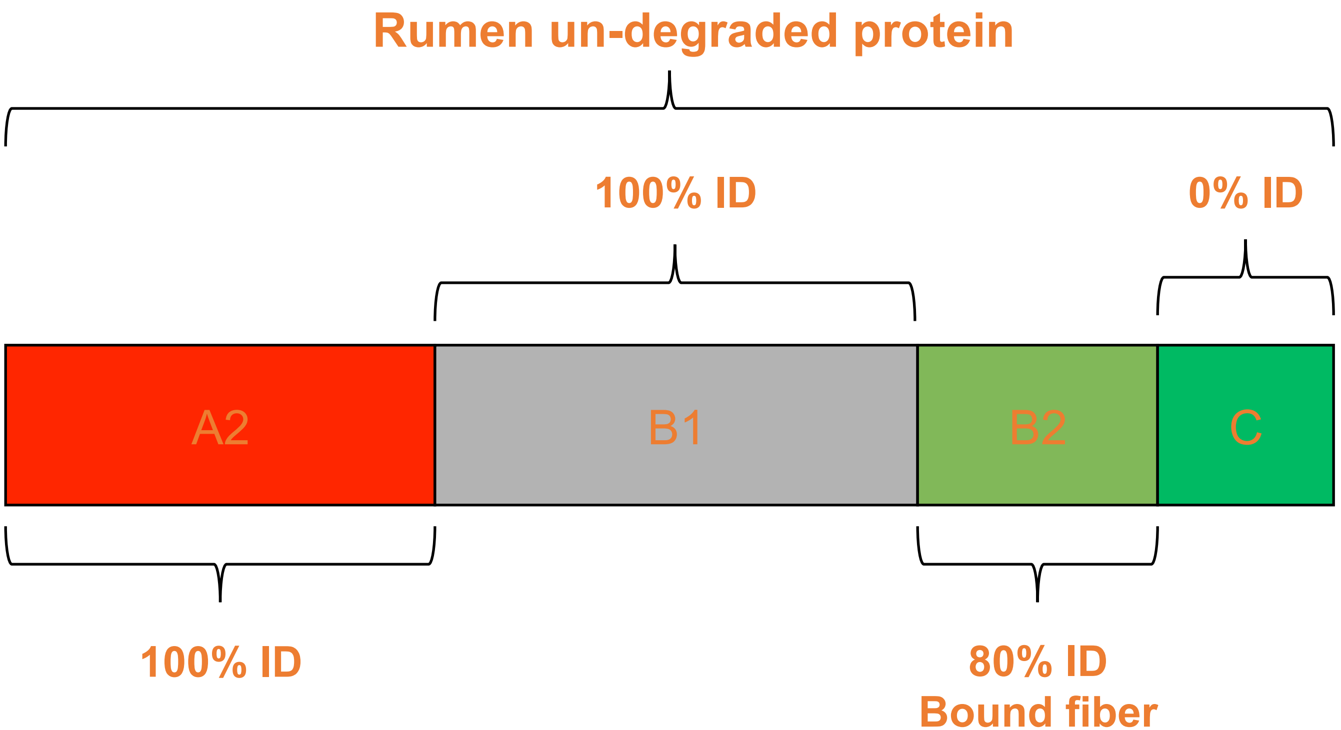
- In Ruminants intestinal digestibility is a calculation.

$$Intestinal\ digestibility = indigestible\ N / rumen\ undegraded\ protein$$

(RUP)



Rumen un-degraded protein
A1
A2
B1
B2
C
Soluble true protein- NH3
CP- other protein
NDIP- ADIP
ADIP
100% ID
100% ID
80% ID
0% ID



- Unavailable protein =
  1. 100% of C fraction (Acid detergent insoluble protein; ADIP)
  2. 20% of B2 fraction (Neutral detergent insoluble protein) - ADIP

Concerns

Use of bags

- microbial barrier for digestion lag
- sample loss

Enzymes: Pepsin & Pancreatin

- Profiles and activities undefined
- Digestion process of ruminant a continuous process

New *In Vitro* ID assay

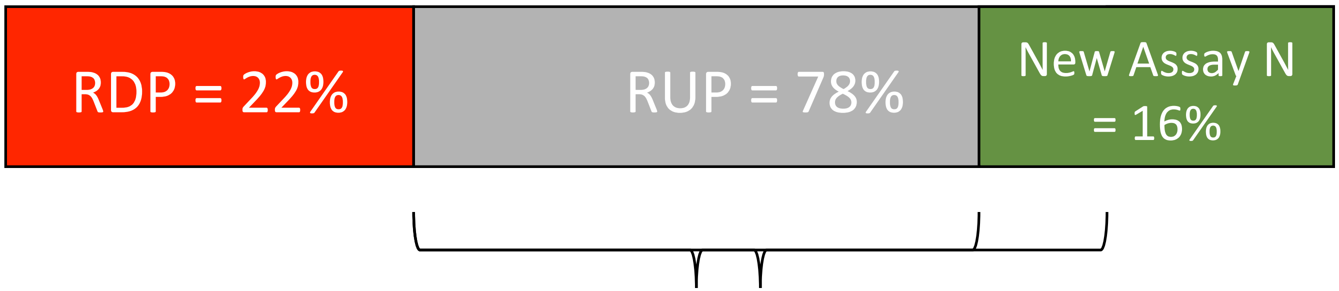
- Modification of existing methods to better estimate N unavailable fraction
  - Flasks instead of bags (sample loss, lag time)
  - Physiological enzyme mix

    Reduce proteolytic activity variation
  - Filtering residue on 1.5 µm, 90 mm glass instead of TCA precipitation

Comparison of ADIN and Ross in-vitro indigestible N

	Feed N (% DM)	ADIN (%N)	Ross In-vitro indigestible N (% N)
Regular blood meal	16.2	4.7	16
Heat damaged blood meal	16.1	1.8	93
Soybean meal solvent extracted	7.6	6.7	8
Soybean meal heat treated	7.3	7.9	11

Source: Ross, 2013



Digestible protein = 79% of RUP

Heat damaged blood meal

Digestible protein = 98% of RUP

Comparison of model predicted MP milk (lb/d) using the current vs new system to estimate ID

- Regular and heat damage blood meal was exchanged on a 1:1 basis.
- All other ingredients remained constant.
- ME allowable milk didn't change

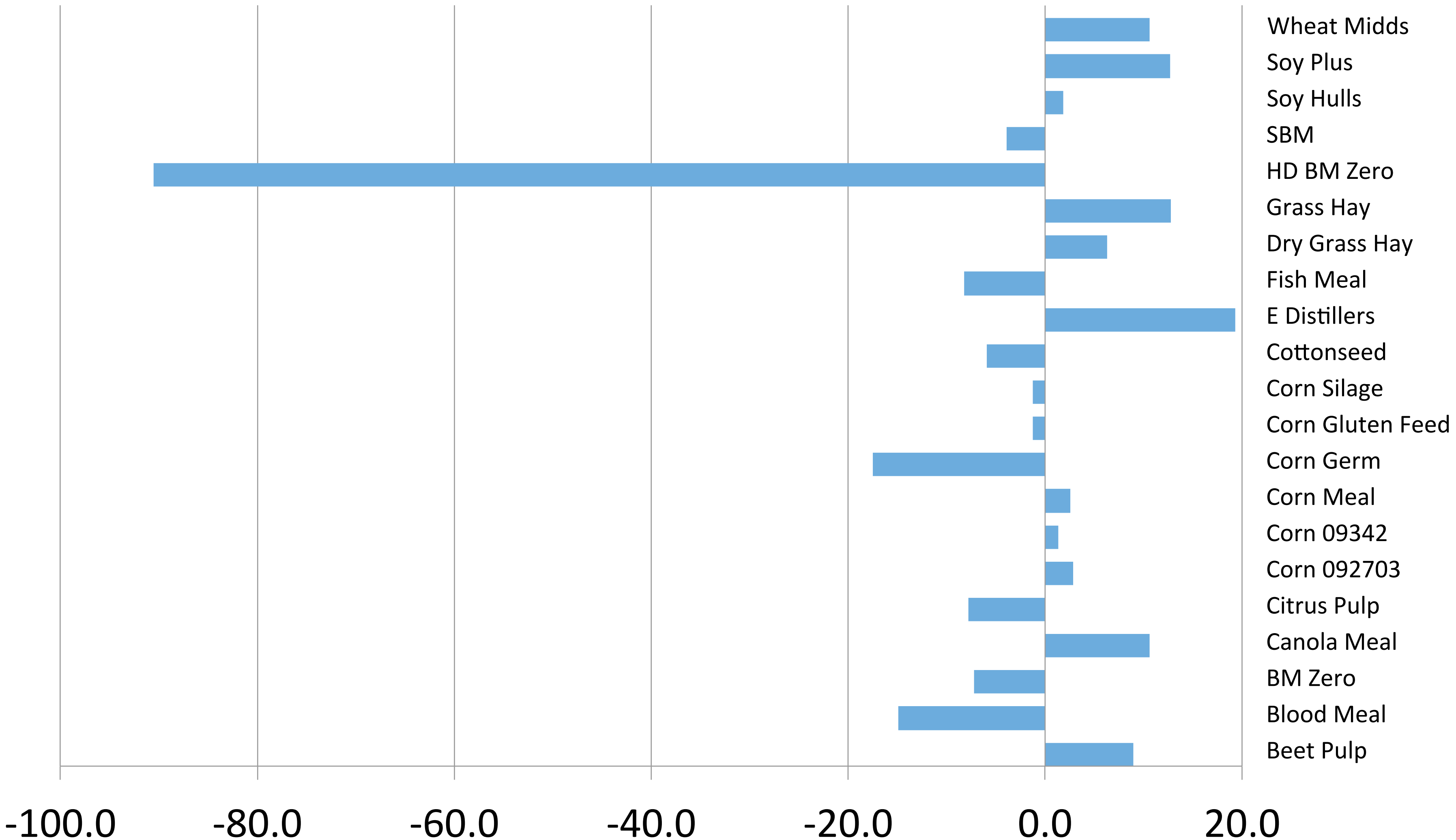
	MP allowable milk (lbs) predicted by the CNCPS	
	Current System	In-vitro System
Regular Blood Meal	85.0	81.3
Heat Damaged Blood Meal	**85.8**	**62.2**

Comparison of Model Predicted MP Milk (kg/d) using the Current vs New System to Estimate ID

- Regular and heat damage blood meal was exchanged on a 1:1 basis.
- All other ingredients remained constant.
- ME allowable milk didn't change

	MP allowable milk (kg) predicted by the CNCPS	
	Current System	In-vitro System
Regular Blood Meal	39.0	37.0
Heat Damaged Blood Meal	**39.4**	**28.0**

Difference in estimated indigestibility between current model library inputs and assay data –> positive means more available protein than currently predicted by the current inputs
Average of the differences is -3.3 units (-HD BM)



COW STUDY - Application of the uN Assay to Predict Intestinal Digestibility of Protein/Nitrogen in Cattle

- Study was conducted on 96 cattle starting at approximately 147 days in milk
- Replicated pen study, 16 cows per pen, three pens per treatment
- Two treatments based on intestinal digestibility
- Measured DMI, Milk yield and compostion, BW, BCS, MUN and PUN

Predicted Difference in N Digestibility

- Treatment difference was created by using two different blood meals
- One blood meal was 9% uN, the other was 34% uN
- Blood meals were fed at iso-N levels
- The calculated difference in N digestibility between the two treatments was 20 g N

Ross Assay/Model Evaluation

- Imputed analyzed composition of feeds
- Imputed environmental, barn, and cattle characteristics
    - BCS change was inputted as measured
    - Target ADG was allowed to estimate nutrient requirements for growth based on mature size
- ADIN values for Bloodmeal replaced with uN values
- Zero intestinal digestibility of uN

CNCPS predictions for ME and MP allowable milk

	Treatment	
Item, lb	LOW uN	HIGH uN
Actual milk	**93**	**89**
Energy corrected milk	92	88
ME allowable milk	99	101
Using NDIN and ADIN		
MP allowable milk	99	98
Using uN assay inputs		
MP allowable milk	94	87

Conclusions

- Assay predictions were consistent with cattle responses
- For non-fiber feeds, like blood meal, the detergent system is not sensitive in defining unavailable nitrogen
- The uN assay improves the model's ability to identify the most limiting nutrient

Amino Acids

New Output parameters

Updated Ratios

Updates to the feed library

Reported by %CP

Changed Efficiencies

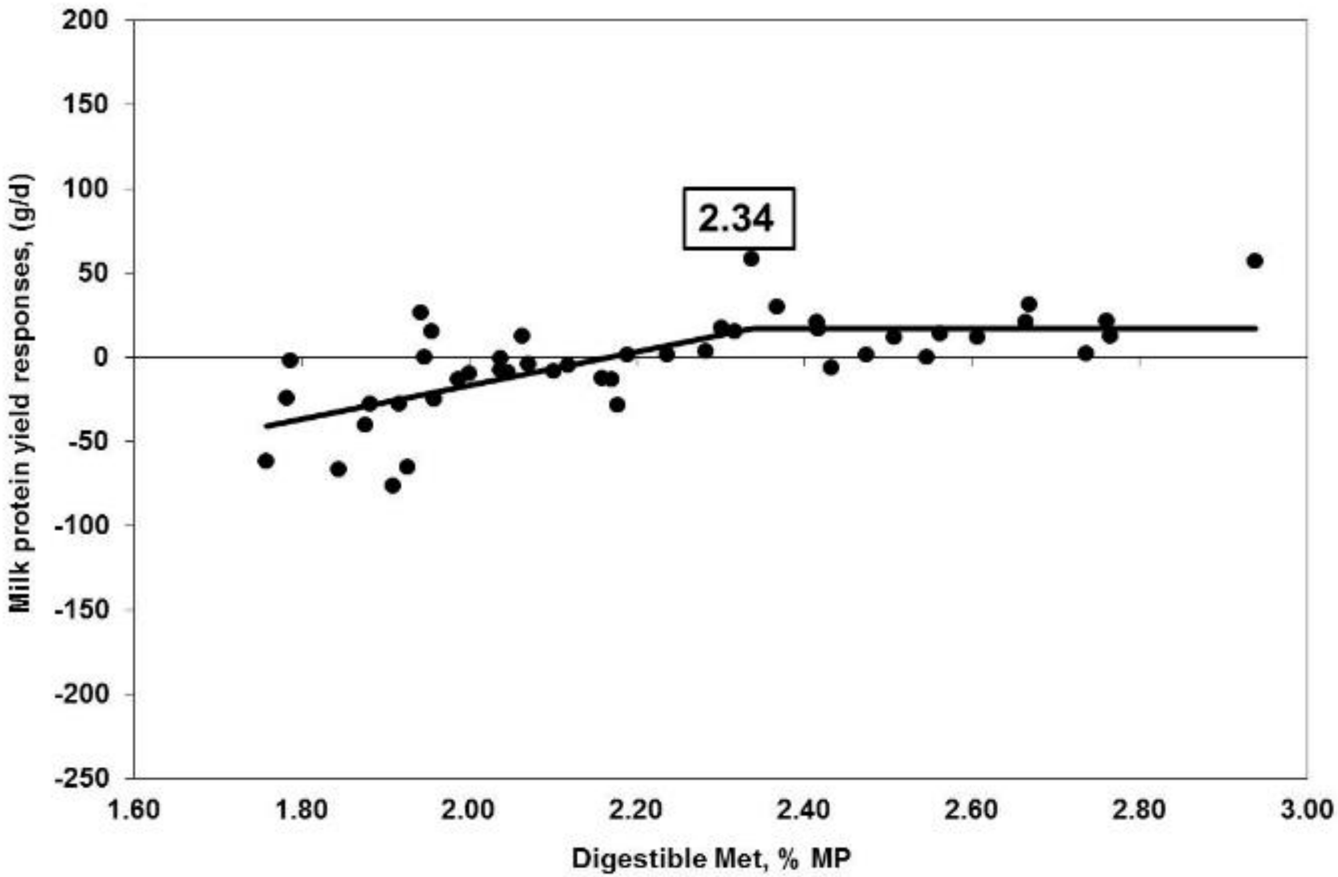
New Output Parameters

Updated Entire Library

- Moved from %ISR to %CP
- Library was seeded from analyses on few feeds performed in the 1990s
- Analysis methods were inadequate
- Old methods and New Methods were included in same library
  - Which lead to underestimation of MET Content in feeds

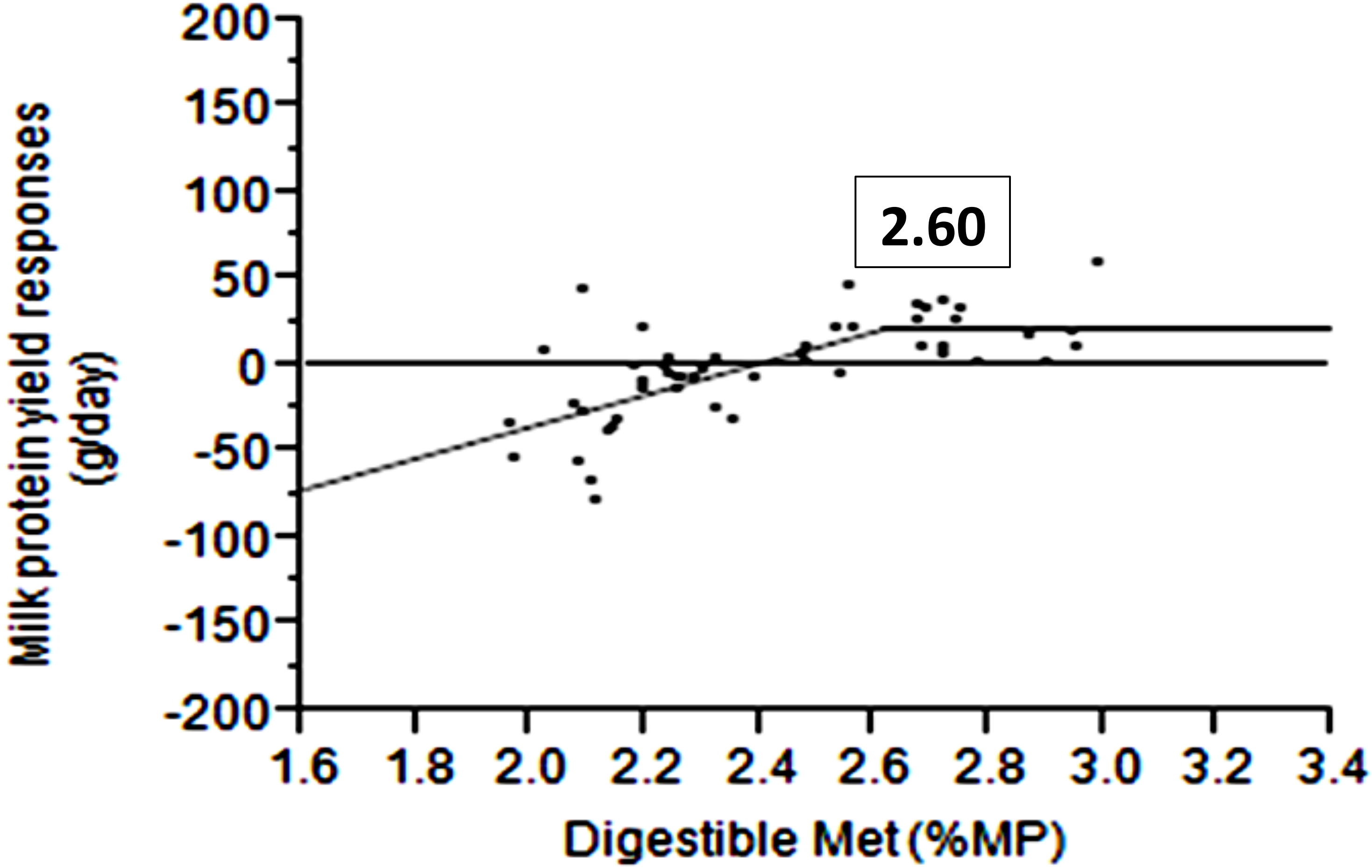
Changed efficiencies for use in Lactating Dairy Cows

Balancing for met – current model



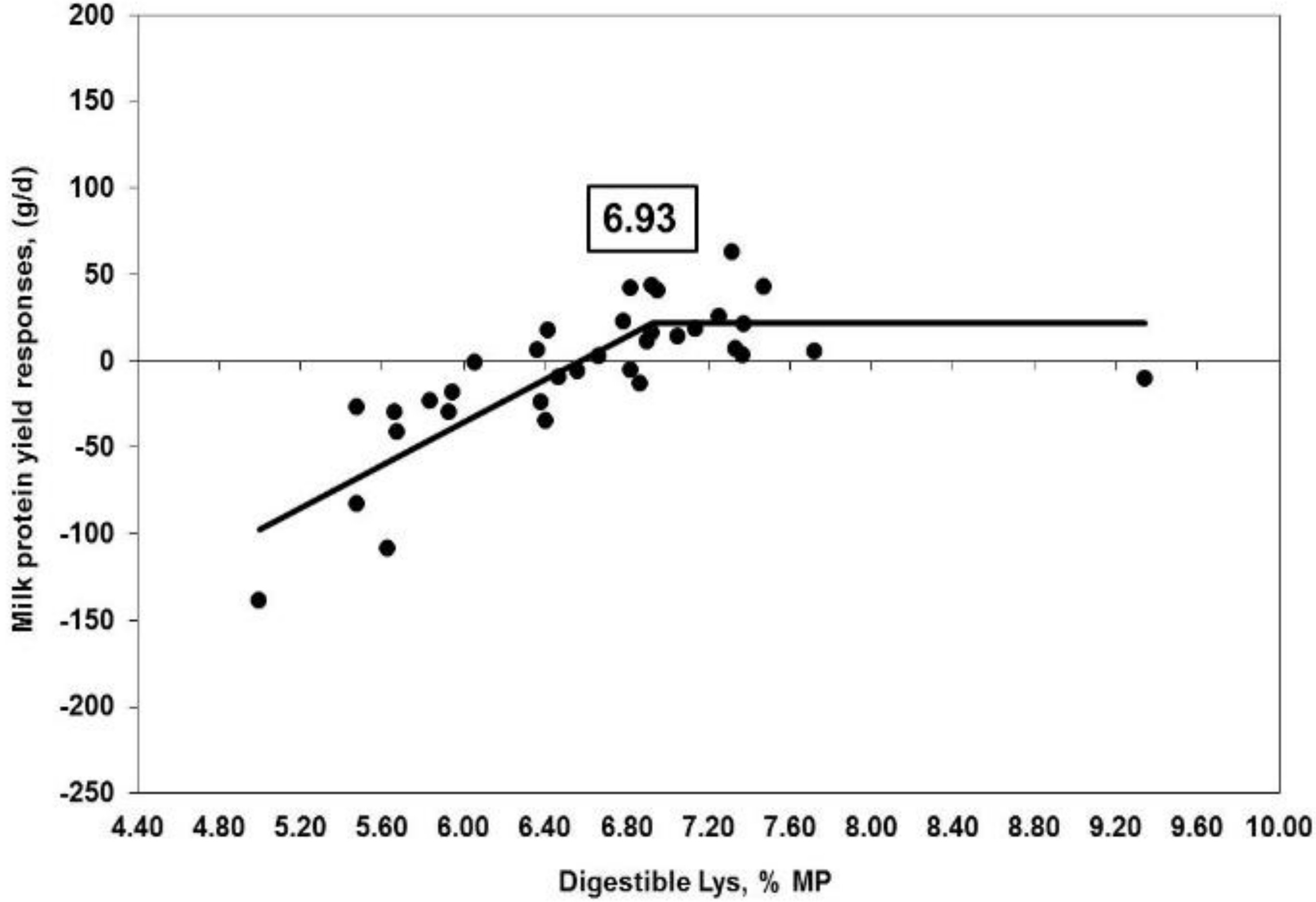
Source: Whitehouse et al., 2013

Balancing for met – updated aa profiles – Milk Protein Yield Response



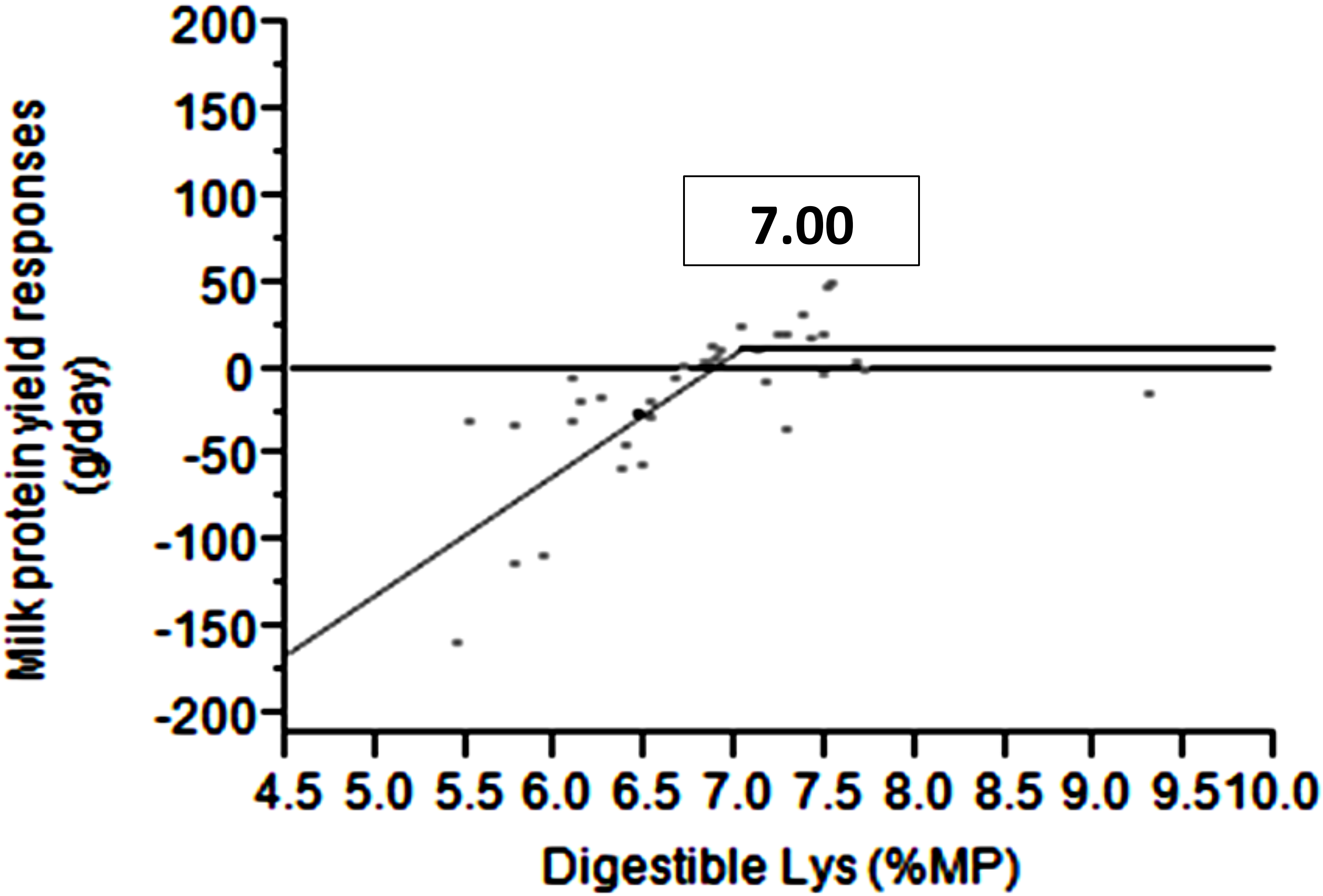
Source: Van Amburgh et al., unpublished

Balancing for lys – current model



Source: Whitehouse et al., 2013

Balancing for LYS – updated aa profiles Milk protein Yield response



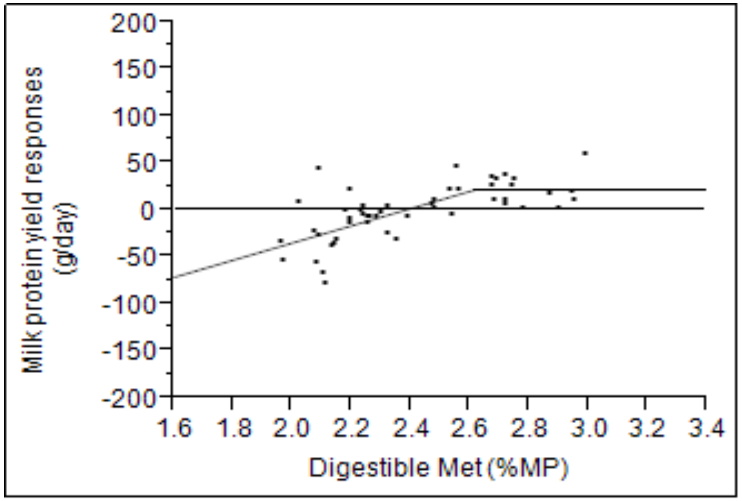
Source: Van Amburgh et al., unpublished

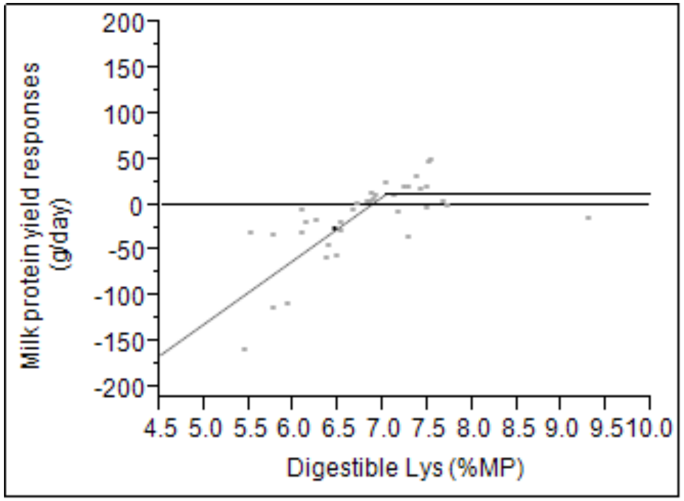
Updating Efficiencies Of AA Use

Amino acid	Maintenance	Lactation	Combined Efficiency (Doepel et al., 2004)
MET	85%	100%	66%
LYS	85%	82%	69%
ARG	85%	35%	58%
THR	85%	78%	66%
LEU	66%	72%	61%
ILE	66%	66%	67%
VAL	66%	62%	66%
HIS	85%	96%	76%
PHE	85%	98%	57%
TRP	85%	85%	65%

Source: Fox et al., 2004, Doepel et al., 2004, Lapierre et al., 2007

AA Evaluation





CNCPSv6.5: 2.60 % MP for Met | 7.00 %MP for Lys

CNCPSv6.1: 2.34 % MP for Met | 6.93 %MP for Lys

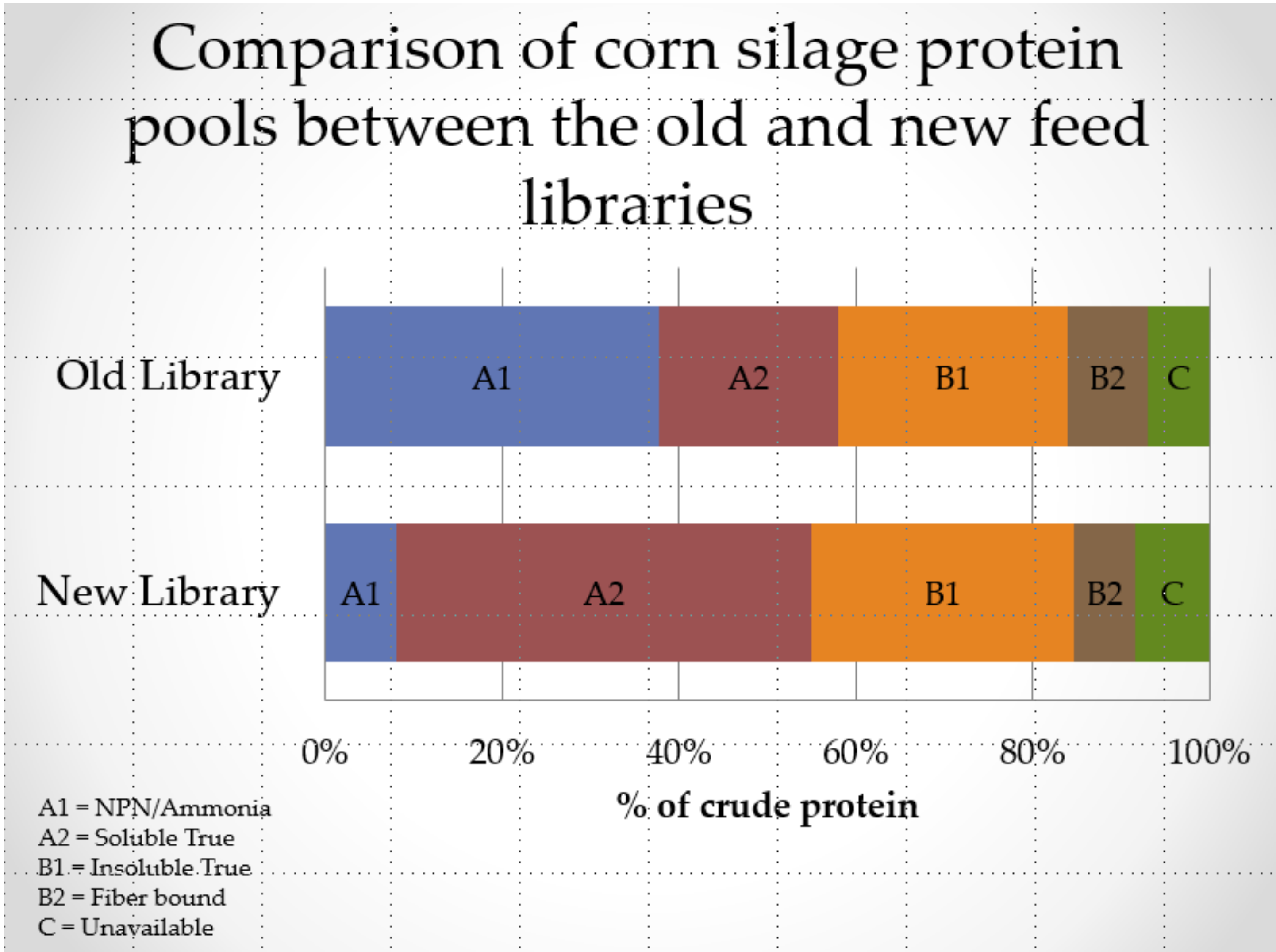
11 % increase in Met | 1% increase in Lys

Ratios
New Recommendations

- Milk protein yield and milk volume are tightly regulated and highly correlated
  - To maximize:
    - MET 1.0 – 1.15 MP g per 1 Mcal ME supply
    - LYS: 2.9 – 3.0 g per Mcal ME

Equal to LYS:MET of 2.65:1

- I would drive LYS as high as possible without RP LYS available and drive MET to 1-1.15 g / Mcal ME


Comparison of corn silage protein pools between the old and new feed libraries
Old Library
New Library
A1
A2
B1
B2
C
A1
A2
B1
B2
C
0%
20%
40%
60%
80%
100%
% of crude protein
A1 = NPN/Ammonia
A2 = Soluble True
B1 = Insoluble True
B2 = Fiber bound
C = Unavailable

Efficiency of AA utilization

CNCPSv.1.0 -6.1

AA requirements

- Maintenance → Efficiency for Maintenance
- Lactation → Efficiency for Lactation

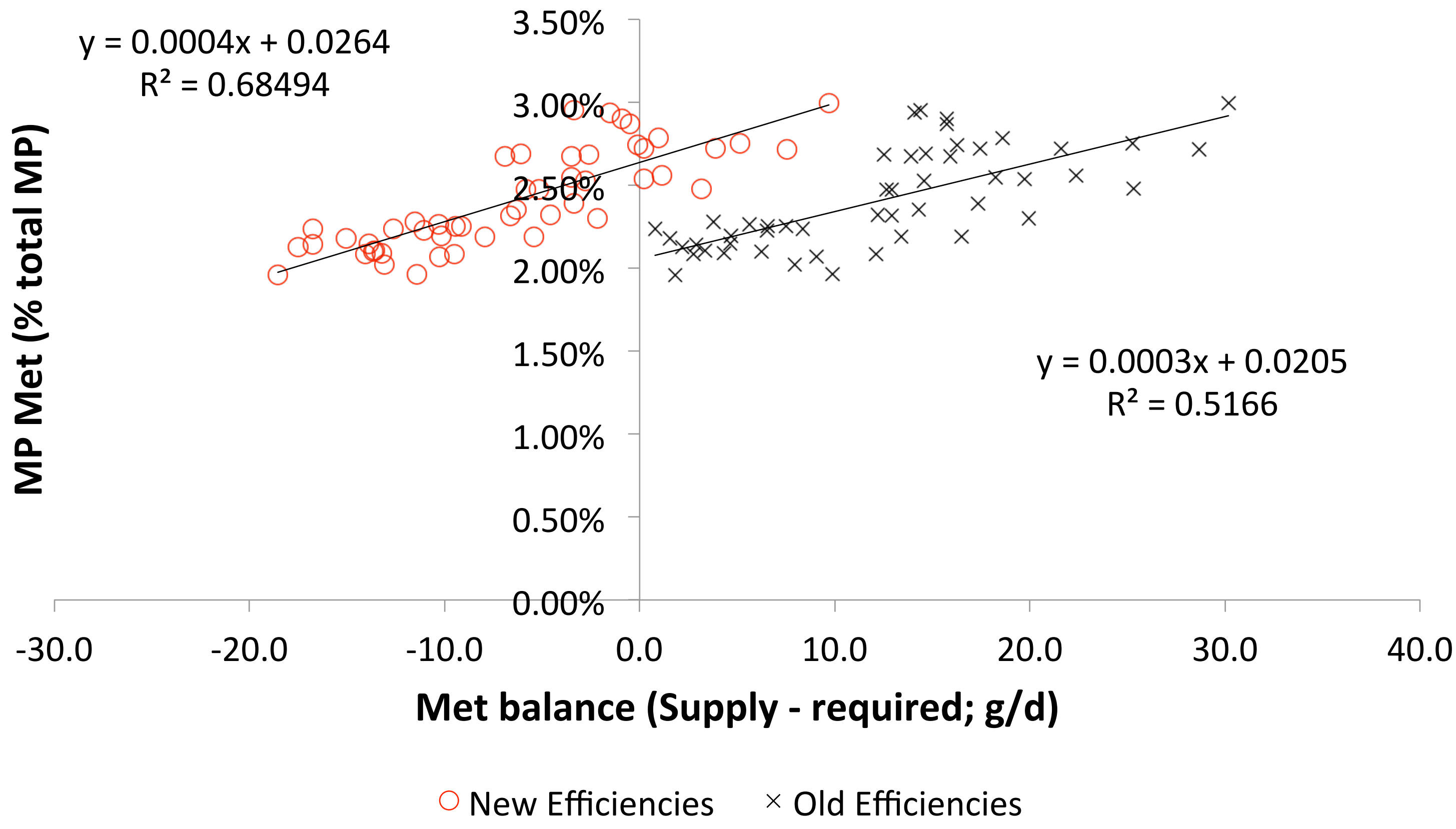
CNC, 2007: Lapierre et al.

AA requirements

- Maintenance
- Lactation

→ Combined Efficiency

Met Balance With New AA Efficiencies



Comparison Of Model Output From The Old And New System

	AA %MP		Balance	
	Old	New	Old	New
MET	2.3%	2.6%	14.0	1.1
LYS	6.2%	6.3%	2.9	-5.3
ARG	5.7%	6.0%	-20.2	-0.2
THR	4.5%	4.6%	33.8	13.6
LEU	8.4%	8.4%	-1.6	-36.7
ILE	4.6%	4.7%	-10.5	-6.7
VAL	5.5%	5.5%	-11.6	-4.2
HIS	2.7%	2.7%	17.0	6.9
PHE	5.0%	5.0%	46.4	-10.2
TRP	1.4%	1.3%	6.5	-4.4

Summary

- CNCPS v6.5 can more accurately and precisely predict Non-Ammonia N flow, but under-estimates Bact N and over estimates Rumen undegraded N – for uniform offsets.
- The adoption of the combined efficiency of use of absorbed protein and AA improved the ability of CNCPS v6.5 to predict milk yield with low protein diets
- Thus, CNCPS v6.5 is more sensitive at predicting most limiting ME or MP allowable milk
- Recommendations for Met are 11% higher than previous versions (2.6 % MP) and other AA were altered slightly

Summary

- ❖Updates to the CNCPS have improved predictions of MP supply
- ❖Partitioning of N flows out of the rumen are close to measured data
- ❖Foundations have been set to improve the models ability to better predict AA supply
- ❖Recommendations for Met are 11% higher than previous versions (2.6 % MP) and other AA were altered slightly resulting in a Lys:Met ratio of 2.64:1

New Guidelines

To maximize milk protein

- MET: 1.1-1.15 g MP MET per 1 Mcal ME Supply

  Or 0.26 – 0.28 g per MJ

- LYS: 2.9-3.0 g per Mcal

  Or 0.69 – 0.72 g per MJ

How does this effect me?

- -More accurate DMI
- -More opportunity to reduce cost of diet and keep production through better predicting of protein and butterfat response in Nitrogen feeding
- -help troubleshooting
- -fine tune well managed herds
- -fix mass balance
- -understanding will provide building blocks for 7.0 biology

Thank you!

For more information contact any of us at AMTS, LLC