Determination of First Limiting Physical Factors in Corn Silage Hybrids: Modeling Multiple Pools of aNDFom

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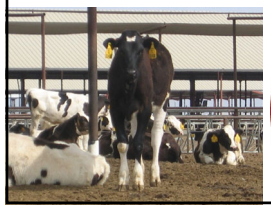
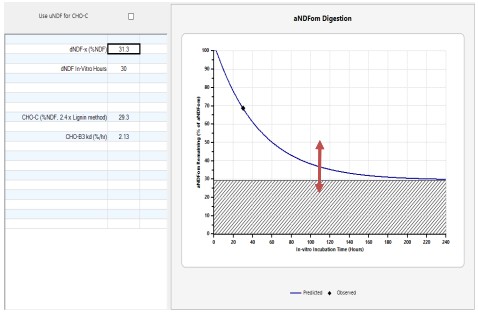


Overview of Today's Discussion

- Rumen fill, NDFom digestibility and uNDF
- Description of corn silage data set
- Modeling multiple pools in CNCPSv7 based on rumen fill and flux using limits established in previous studies (uNDF) or provided by Mertens (total NDF)
- Summarize

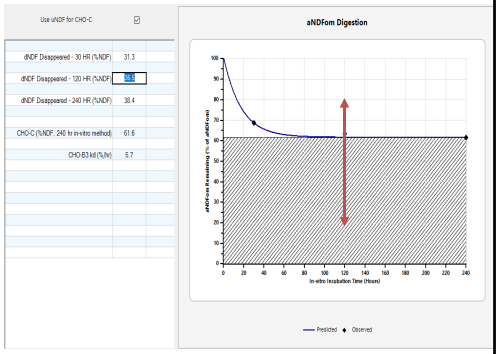
NDF digestibility in CNCPS using lignin*2.4 to estimate uNDF

- Traditional single time point:
- Used 30 h NDFd:
  - 31.3 % of NDF
- Lignin 2.4 as estimation of iNDF:
  - 29.3 % of NDF
- Kd: 2.13 %/h

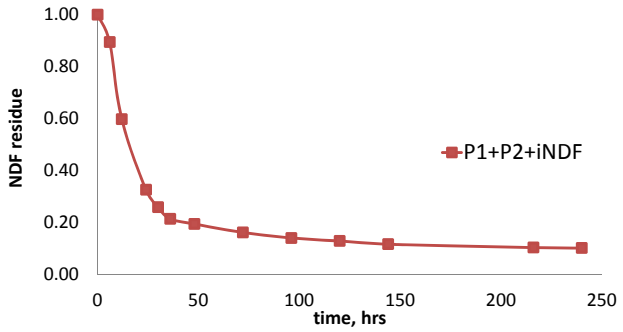


NDF digestibility in CNCPS using uNDF240

- 3 time point
  - 30h: 31.3 %
  - 120h: 36.5 %
  - 240h: 38.4 %
- Measured uNDF
  - 61.6 % of NDF
- Kd: 5.7 %/h



Corn silage example: $NDF_{digestibility}$



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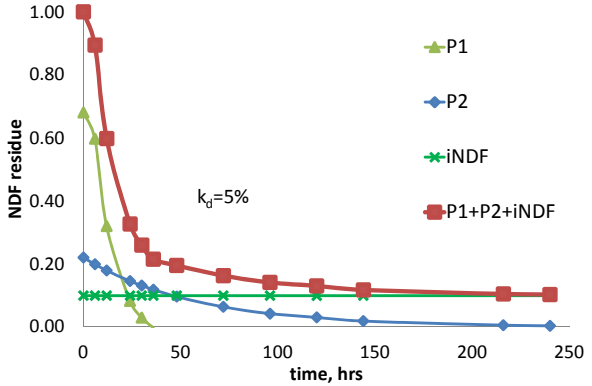
Corn silage example: P1+P2+iNDF



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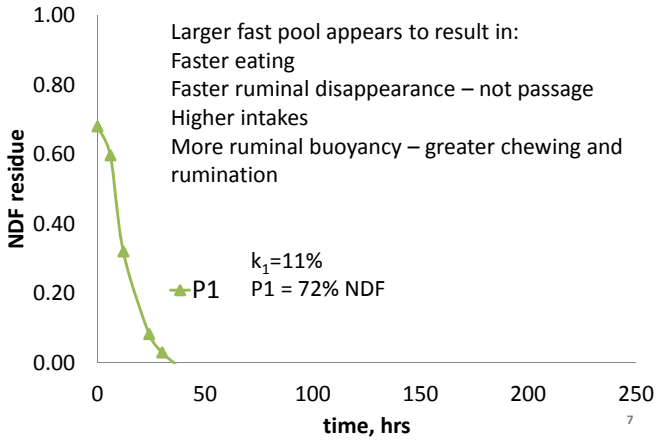
Corn silage example: fast pool



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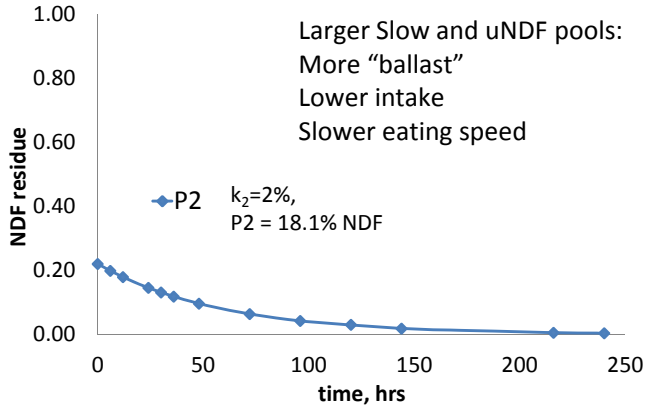
Corn silage example: slow pool



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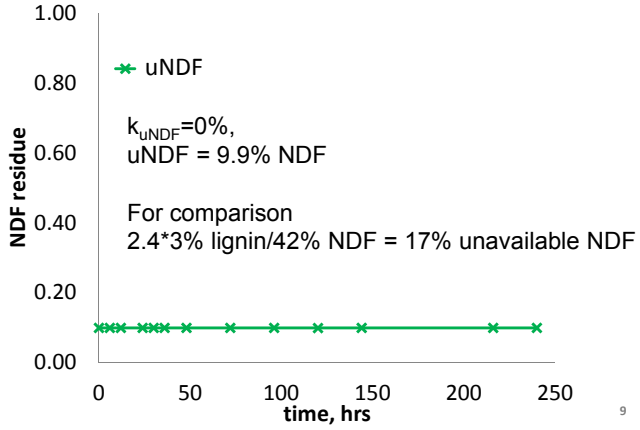
Corn silage example: iNDF



Corn Silage Data Set

- Corn silage test set from 2017
- 648 hybrids
- Analyzed for chemical composition
- Evaluated through CNCPS v7 at constant aNDFom and uNDF rumen fill – allows for evaluation of potential intake effect

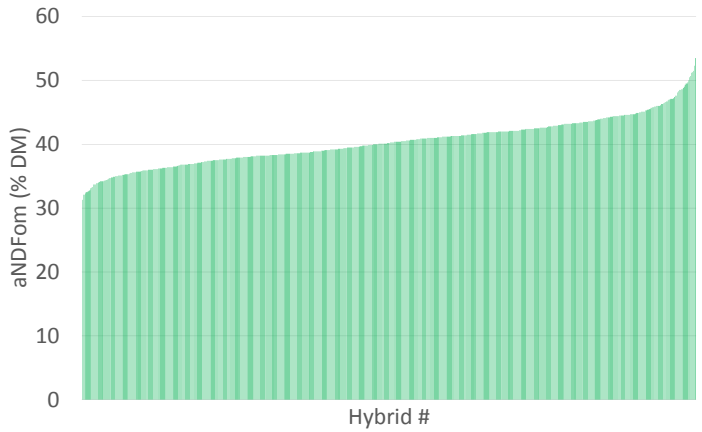
Kerwin, Lawrence, Overton

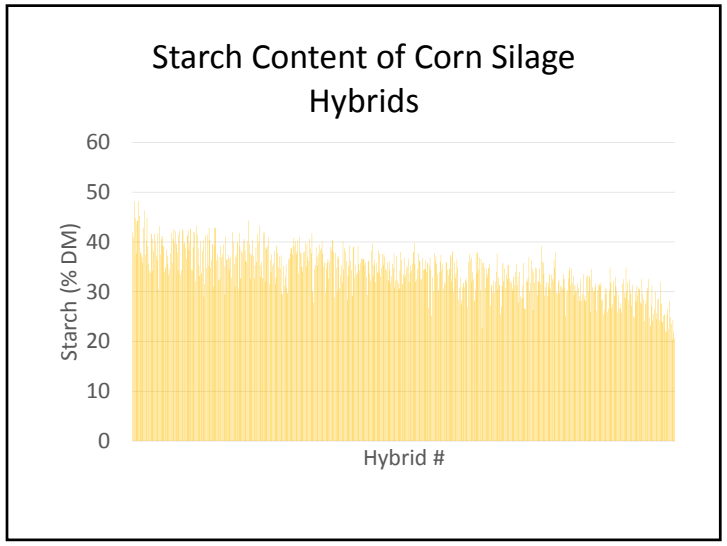
Seed companies that participated in this hybrid evaluation process.

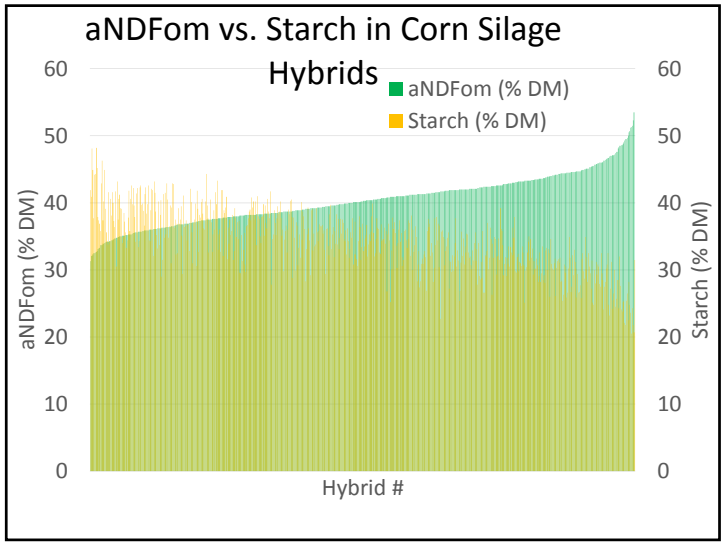
Hubner Seed	Dyna-Gro
Schlessman Hybrids	King Fisher
Growmark FS	Seedway
Dekalb	Augusta Seed
Pioneer	Wolf River Valley Seeds
Dairyland Seed	Doelber's
NK Syngenta	Channel
Masters Choice	Dyna-Gro

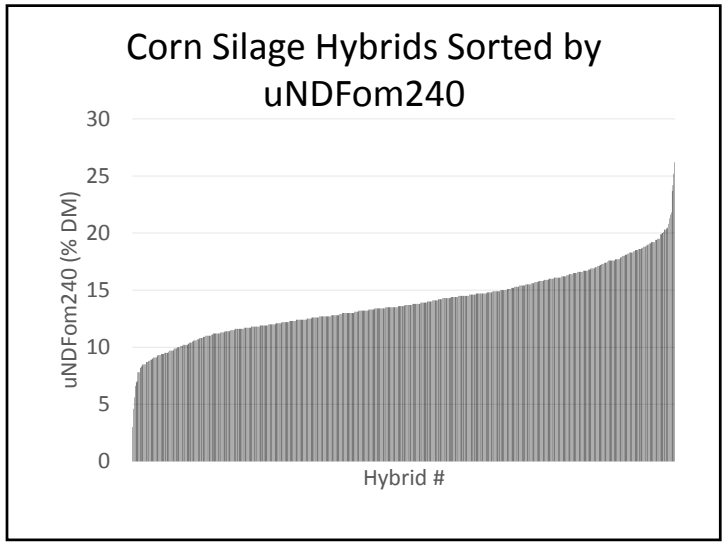
The agronomic conditions are described in the paper

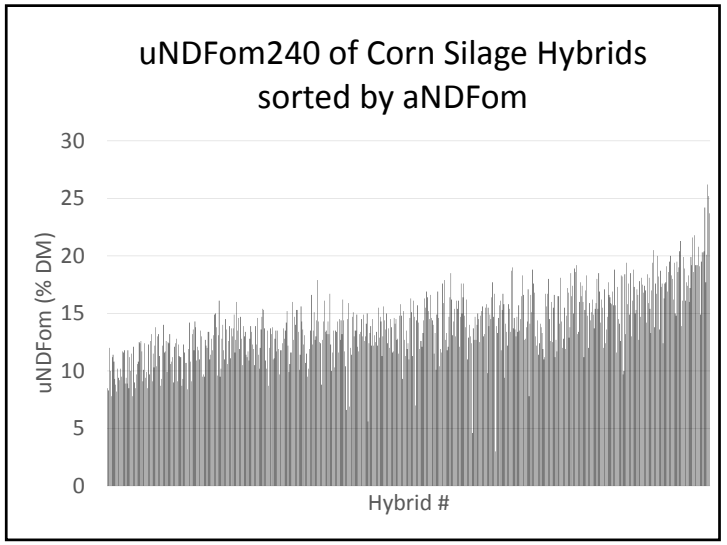
aNDFom of Corn Silage Hybrids

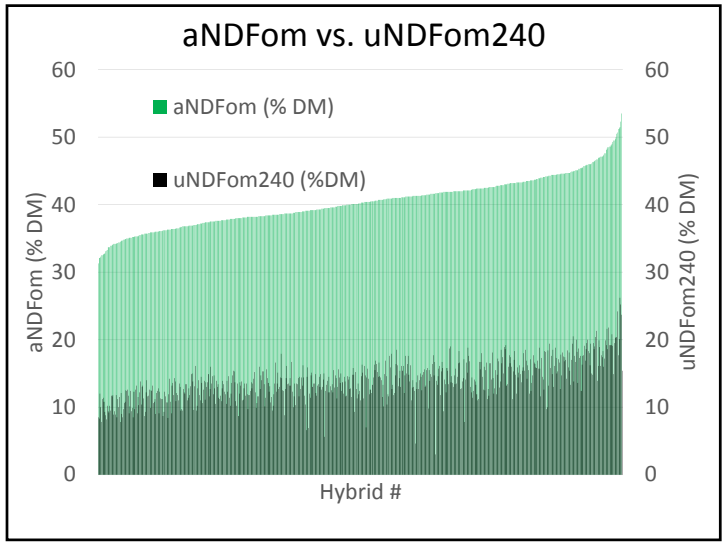


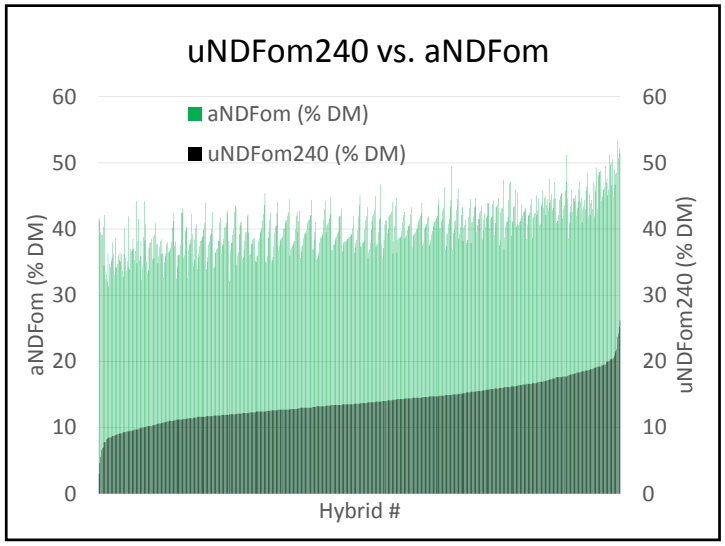

Starch Content of Corn Silage Hybrids
60
50
40
30
20
10
0
Starch (% DM)
Hybrid #


aNDFom vs. Starch in Corn Silage Hybrids
aNDFom (% DM)
Starch (% DM)
60
50
40
30
20
10
0
aNDFom (% DM)
Starch (% DM)
Hybrid #


Corn Silage Hybrids Sorted by uNDFom240
30
25
20
15
10
5
0
uNDFom240 (% DM)
Hybrid #


uNDFom240 of Corn Silage Hybrids sorted by aNDFom
30
25
20
15
10
5
0
uNDFom (% DM)
Hybrid #





Rumen fill and function

- What factors play a role in the ability of the rumen to stay full?

Internal/Intrinsic factors	External factors
Pool sizes	Feed availability
Digestibility	Cow time budget
Indigestibility	Feed quality – palatability, etc
Digestion rate	
Passage rate	
Particle size	

What about aNDFom intake

- Guidelines provided by Dave Mertens over the last 20 years.
- How much aNDFom should a 750 kg cow have in her rumen under steady state conditions?
- Rule of thumb says ideally she should be consuming 1.25% of BW aNDFom - Miner data ranges from 1.27 to 1.47%
- If so, then 9.4 kg at steady state?
- How much should be in her rumen at any one time?

NDF intake as percent BW

Week of lactation	First Lactation	Second + Lactation
2	0.78	0.87
4	0.91	1.00
8	1.05	1.17
12	1.12	1.26
16	1.14	1.29
20	1.14	1.30
24	1.13	1.27
28	1.11	1.24
32	1.08	1.19
36	1.04	1.13
40	1.01	1.08
44	0.97	1.01
Dry cows	0.92	0.95

Mertens, 2009

Animal characteristics and model inputs for the higher and lower intake evaluation groups.

Animal inputs	Base High	Base Low
Dry matter intake, kg	24.50	22.84
Milk production, kg	41	36
Milk fat, %	3.7	3.7
Milk true protein, %	3.1	3.1
Milk lactose, %	4.78	4.78
Body condition score	3	3
Target body condition score	3	3
Age of first calving	22	22
Days in milk	110	110
Mature weight, kg	803	803
Age, months	39	39
Current weight, kg	750	750

Formulation values – Total aNDFom and uNDF Rumen fill limits

- 1,650 lb cattle (750 kg) cattle – 18 lb (8.2 kg) rumen aNDFom – 1.08% BW
- Miner data suggested 1.28% BW aNDFom in rumen as maximum – conditional on size of uNDF pool digestibility - consistent with the “thumb rule” of 1.2% BW aNDFom intake
- uNDF - 10.6 lb (4.8 kg) rumen uNDF - (0.64% BW)
- Miner data 0.62% BW for uNDF limit
- Data from other rumen evacuations corroborates these values

Model calculations related to rumen fill and passage

- 8,200 g maximum intake for aNDFom
- 4,800 g maximum intake for uNDF

For 750 kg cow consuming 54 lb of DM:

- aNDFom kp = 1.6%/h
- Concentrate kp = 6.7%/h
- Liquid kp = 12.1%/h

Modeling comparisons using Rumen Fill for aNDFom and uNDF

- Standard diet – Corn silage 35% DM 37% NDF
- High aNDFom digestibility corn silage variety
  - 10% lower rumen fill
- Lower aNDFom digestibility corn silage variety
  - 10% greater rumen fill
- Use model to estimate DMI at first limiting rumen fill set point or be within the limits of expected fill

Formulation values – Standard diet for this comparison

- 1,653 lb (750 kg) producing 90 lb (41 kg) milk consuming 54 lb (24.5 kg) DMI which is 32% aNDFom
- 17.28 lb aNDFom intake (7.84 kg)
  - 7,840 g aNDFom intake
  - 1 % body weight
  - 2017 Agronomic factors created higher uNDF making it difficult to meet typical corn silage intakes

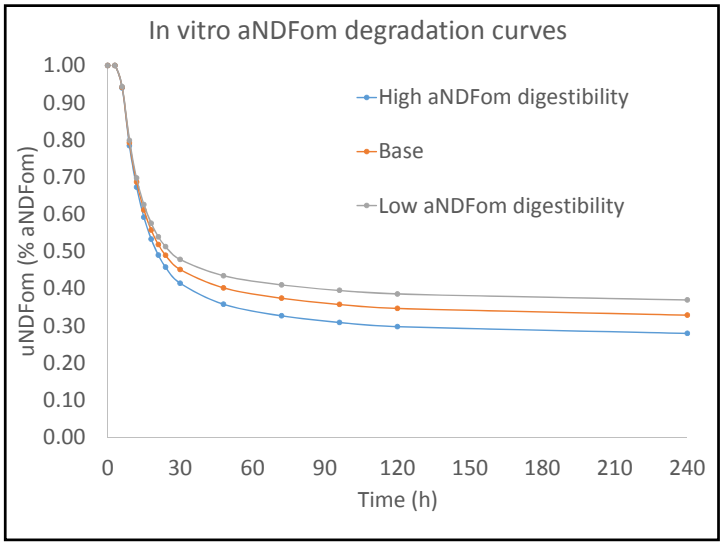
Chemical Composition	
CP (% DM)	16.3
SolP (% CP)	42.5
Ammonia (% SP)	7.9
ADIP (% CP)	6.5
NDIP (% CP)	15.8
NFC (% DM)	41.6
Sugars (% DM)	3.4
Starch (% DM)	29.9
aNDFom (% DM)	31.8
peNDF	58.4
Lignin (% NDF)	9.4
Ether extract (% DM)	4.4
Ash (% DM)	6.6
Forage (% DM)	60.3

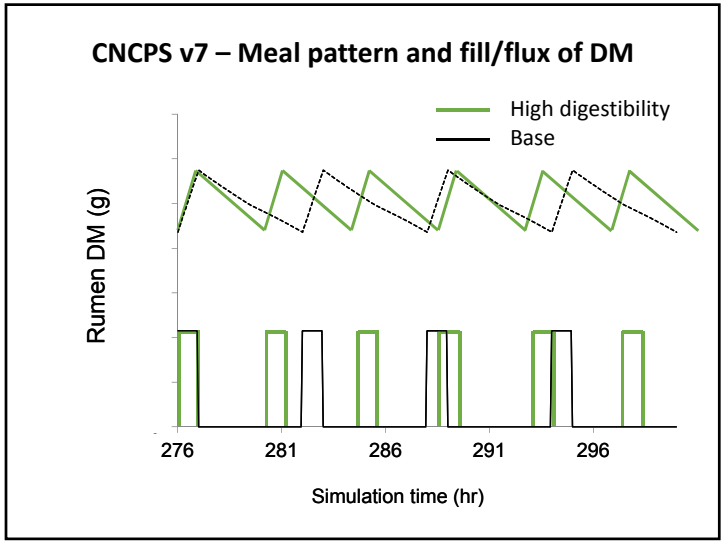
Formulated Base Diet

Chemical composition	
Fast pool aNDFom (% aNDFom)	55.4
Fast pool aNDFom (% DM)	17.6
Slow pool aNDFom (% aNDFom)	16.6
Slow pool aNDFom (% DM)	5.3
uNDFom pool (% aNDFom)	22.2
uNDFom pool (% DM)	7.1

Diet ingredient	lb DM	Inclusion level %
Corn Silage Processed 35 DM 41 NDF Medium	22.46	42
Grass Silage 20 CP 48 NDF 5 LNDF	10.11	19
Corn Grain Ground Fine	9.17	17
Canola Meal Solvent	2.18	4
Corn Dist Ethanol	0.83	2
Soybean Hulls Ground	1.11	2
Citrus Pulp Dry	1.11	2
Wheat Midds	2.21	1
Soy Plus	1.96	4
Blood Meal Average	0.92	2
Energy Booster 100	0.37	1
MinVit +Urea + Smartamine M	1.55	3.1
Total	54.00	100

Chemical composition	Low aNDFom digestibility	Base	High aNDFom digestibility
CP (% DM)	7.0	7.5	8.1
aNDFom (% DM)	37.7	37.3	37.8
Starch (% DM)	36.0	37.1	32.1
uNDFom30 (% aNDFom)	47.8	45.1	41.4
uNDFom120 (% aNDFom)	38.6	34.7	29.8
uNDFom240 (% aNDFom)	36.7	32.6	27.7
Fast pool aNDFom (% aNDFom)	49.5	51.8	55.4
Slow pool aNDFom (% aNDFom)	13.0	15.0	16.0
uNDFom pool (% aNDFom)	36.7	32.6	27.7
Fast kd (%/h)	12.4	12.1	11.6
Slow kd (%/h)	1.8	1.8	1.8
Integrated kd (%/h)	6.3	5.9	5.9





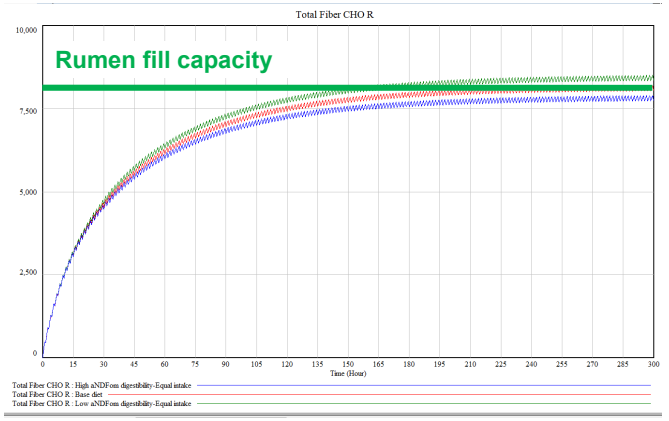
CNCPS v7 Model Output – Rumen Pool Sizes and DMI

	Low aNDFom digestibility	Standard	High aNDFom digestibility
B3 Fast CHO	1588	1632	1698
B3 Slow CHO	1588	1655	1715
C CHO	5239	4819 (0.64% BW)	4395
Total rumen NDF	8415	8106 (1.1% BW)	7809
DMI	24.5	24.5	24.5

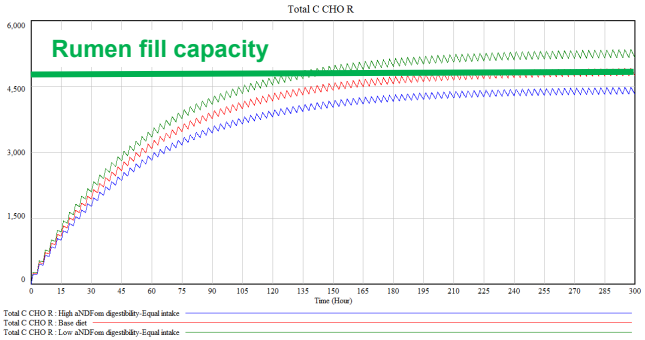
Rumen Fill and Rumen Function

- The low digestibility will overfill – thus intake drops
- The high digestibility will under fill – thus opportunity for greater DMI
- What happens to the high digestibility diet when time budgets are off, feed availability is reduced, or inventories are tight?
- What if aNDFom was formulated at 28% DM instead of 30%

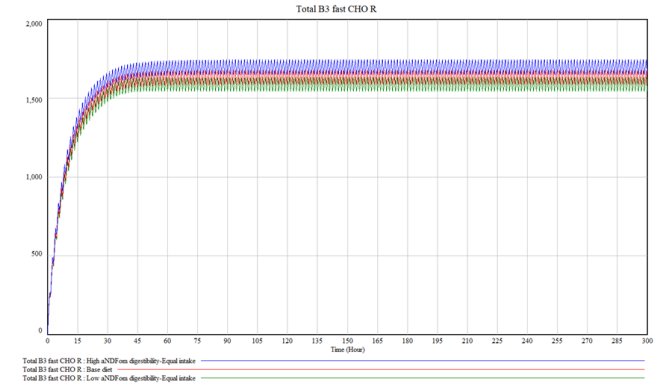
CNCPS v7 Rumen Fill aNDFom at Equal DMI



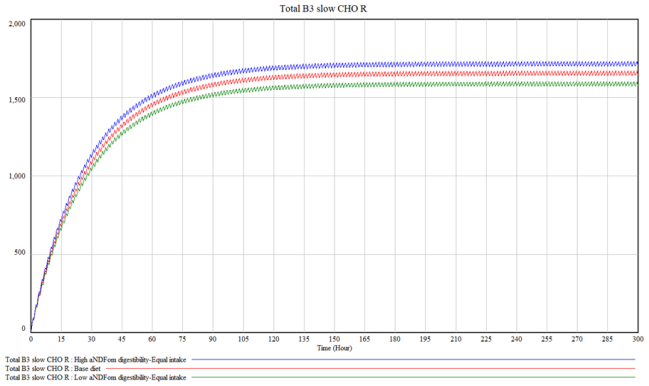
CNCPS v7 Rumen Fill uNDFom – DMI set to equal



Fast Pool aNDFom at equal DMI



Slow Pool aNDFom at equal DMI



CNCPS v7 Model Output – estimated DMI based on first limiting for fill – aNDFom or uNDF

	Low aNDFom digestibility	Standard aNDFom digestibility	High aNDFom digestibility
B3 Fast CHO, g	1464	1632	1763
B3 Slow CHO, g	1462	1655	1780
C CHO, g	4819	4819	4563
Total rumen NDF, g	7745	8106	8106
DMI, kg	22.5	24.5	25.4
ME allowable milk	35.8	40.9	43.3

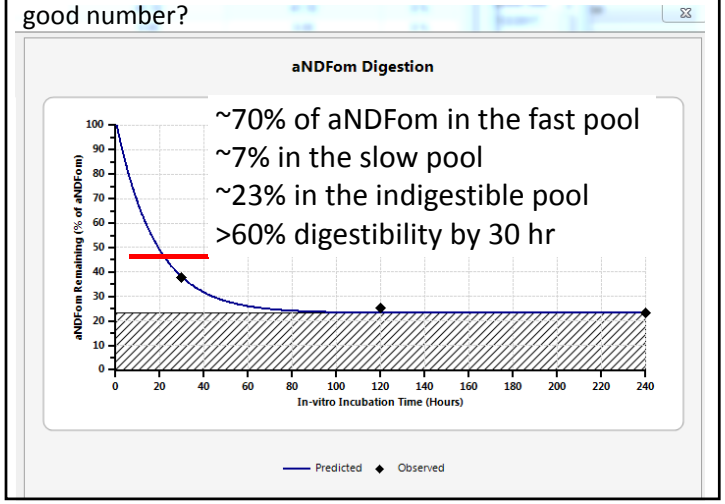
Corn silage evaluation

- This approach consistent with a nutritionist that has to substitute corn silage with other forage or non-forage fiber sources to maintain milk yield when digestibility decreases or uNDF increases
- Or has the ability to feed more forage/DM when digestibility increases
- Currently does not account for yield or have economics integrated in the evaluation

Summary

- This modeling approach allowed us to integrate some concepts of physical fill and describe digestion of aNDFom in the rumen and evaluate “first limiting” physical fill factors
- Suggests estimates of DMI can be evaluated at the time of diet formulation to determine the feasibility of application
- Further work will continue to develop datasets that allow us to challenge our understand of rumen fill and emptying to better predict potential differences in feed intake based on physical and chemical components of the diet to improve diet formulation capacity

Corn silage chemistry – NDF fractions – what is a good number?



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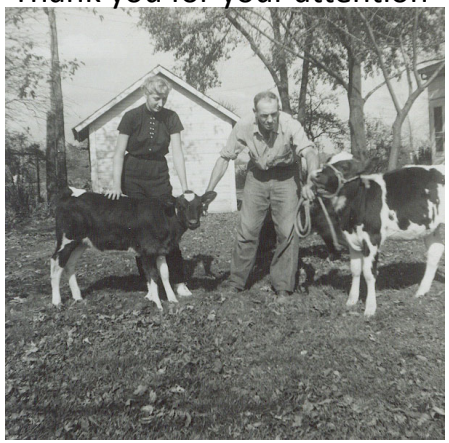

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