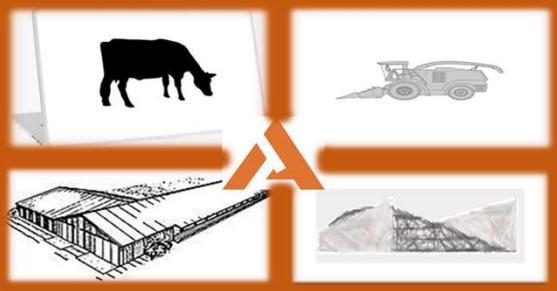
Improving Production & Components With Dynamic Rumen Models

2022
Georgia Dairy Conference



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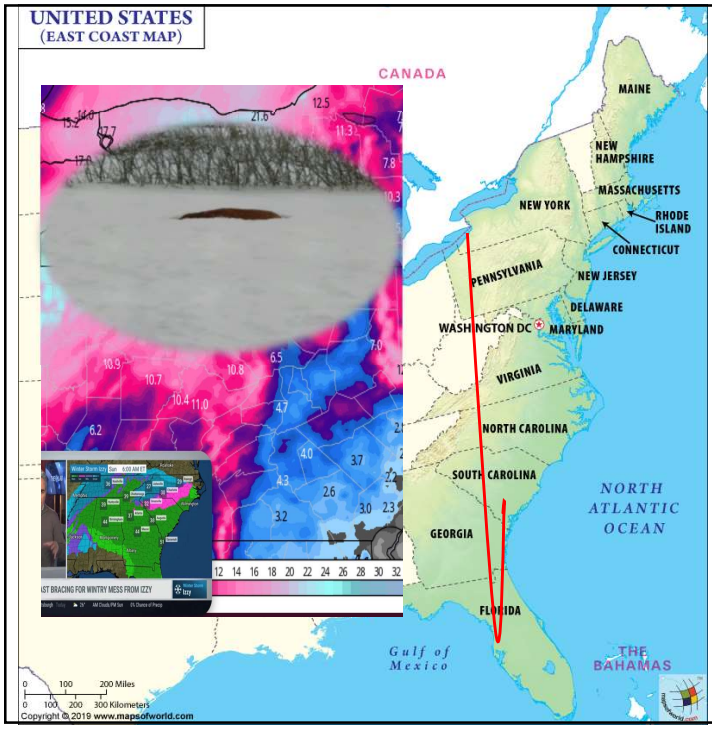

- 25 years Dairy Nutrition
- 20 years Forage Specialist
- Focus on Forage Harvest & Mycotoxin Management

2


Be the best you can be…..
So that others can flourish

3


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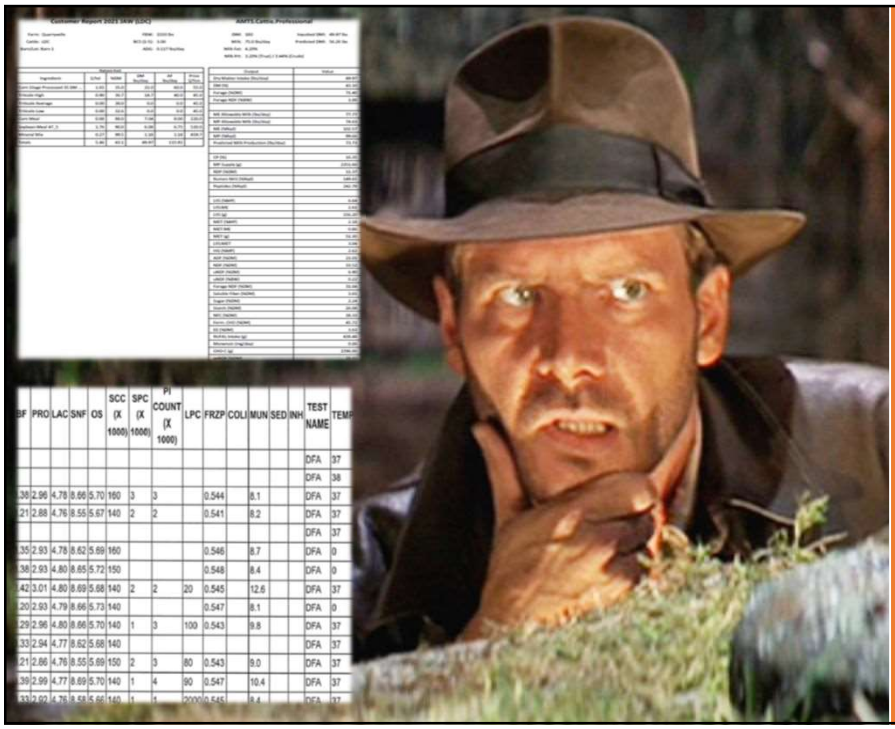

BF	PRO	LAC	SNF	OS	SCC (X 1000)	SPC (X 1000)	PI COUNT (X 1000)	LPC	FRZP	COLI	MUN	SED	INH	TEST NAME	TEMP
														DFA	37
														DFA	38
.38	2.96	4.78	8.66	5.70	160	3	3		0.544		8.1			DFA	37
.21	2.88	4.76	8.55	5.67	140	2	2		0.541		8.2			DFA	37
														DFA	37
.35	2.93	4.78	8.62	5.69	160				0.546		8.7			DFA	0
.38	2.93	4.80	8.65	5.72	150				0.548		8.4			DFA	0
.42	3.01	4.80	8.69	5.68	140	2	2	20	0.545		12.6			DFA	37
.20	2.93	4.79	8.66	5.73	140				0.547		8.1			DFA	0
.29	2.96	4.80	8.66	5.70	140	1	3	100	0.543		9.8			DFA	37
.33	2.94	4.77	8.62	5.68	140									DFA	37
.21	2.86	4.76	8.55	5.69	150	2	3	80	0.543		9.0			DFA	37
.39	2.99	4.77	8.69	5.70	140	1	4	90	0.547		10.4			DFA	37
.33	2.93	4.78	8.58	5.66	140	1	1	2000	0.545		9.4			DFA	37

Unlock the mysteries

- ❖ Wild Yeast
- ❖ Bunk Density
- ❖ Harvest Dry Matter
- ❖ Corn Processing
- ❖ NDF Digestibility
- ❖ Ration UNDF
- ❖ Component Relationships
- ❖ Fermentation
- ❖ Repro and Cow Health

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Unlock the mysteries

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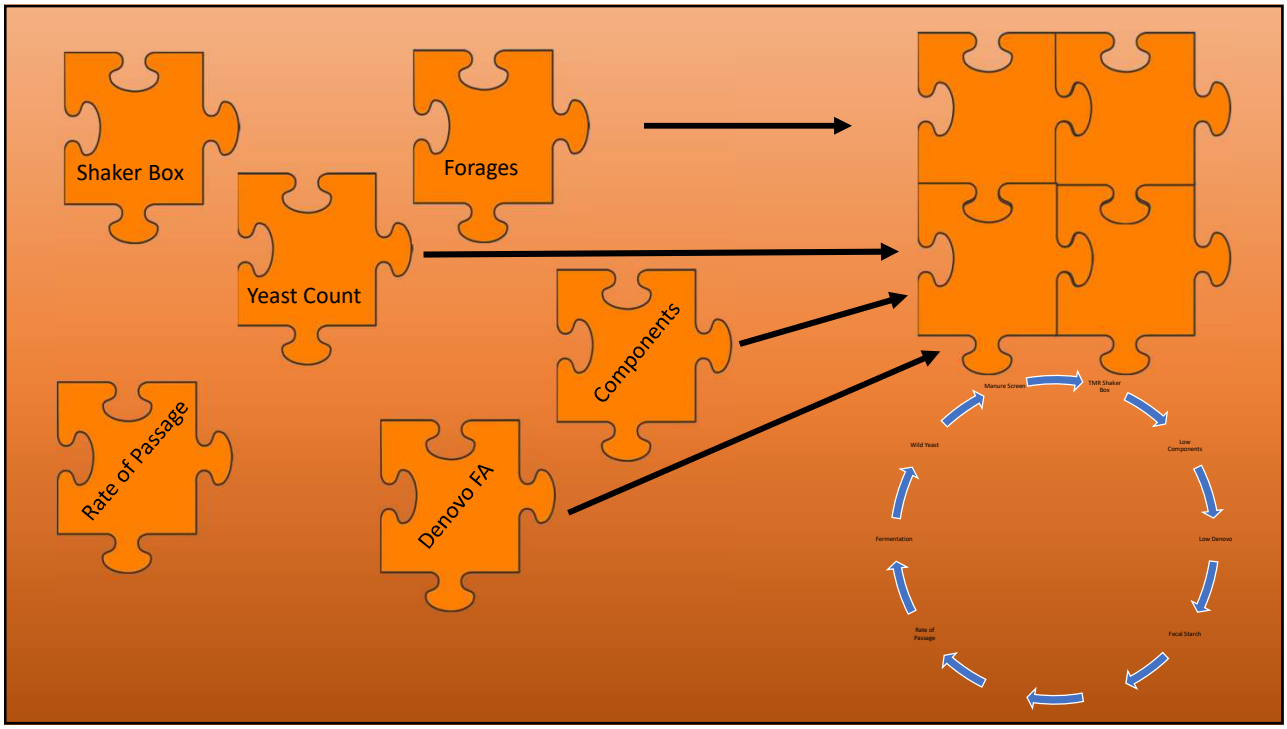
Shaker Box
Forages
Yeast Count
Components
Rate of Passage
Denovo FA
Manure Screen
TMR Shaker Box
Low Components
Low Denovo
Fecal Starch
Rate of Passage
Fermentation
Wild Yeast

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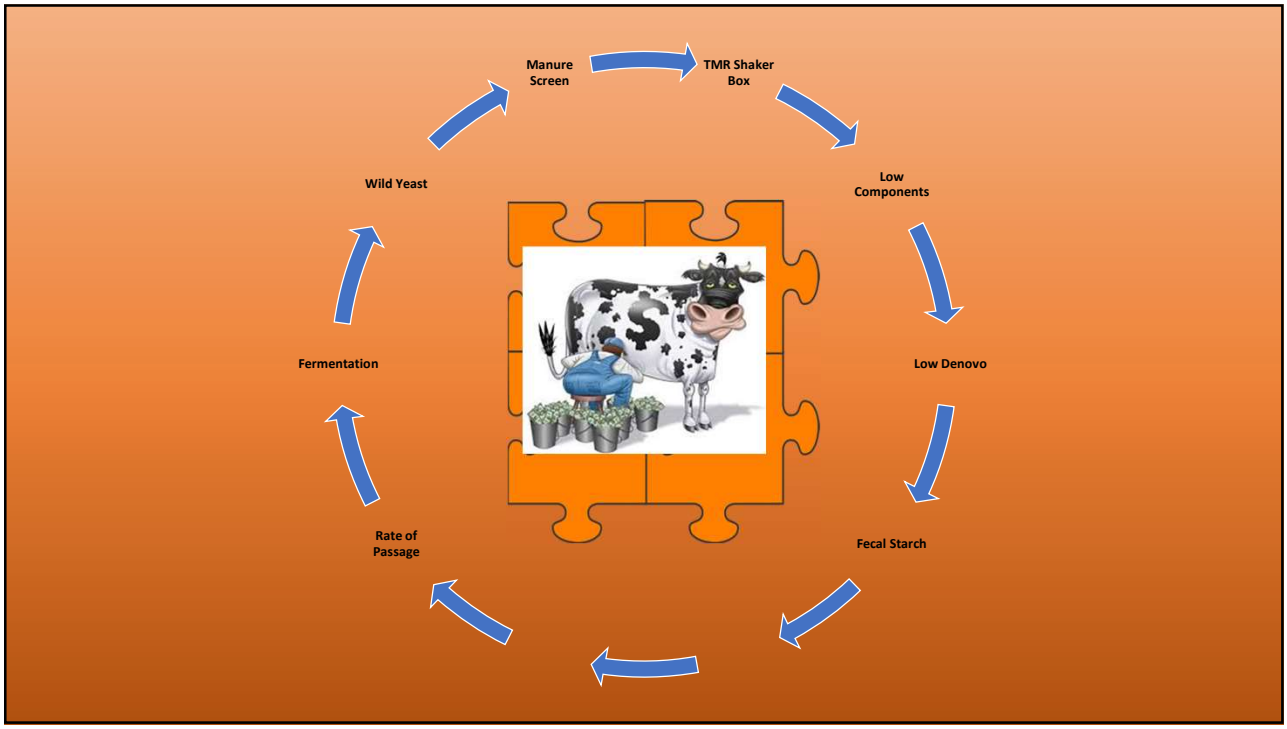
Manure Screen
TMR Shaker Box
Low Components
Low Denovo
Fecal Starch
Rate of Passage
Fermentation
Wild Yeast

8

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Carbohydrate synchronization puzzle

- Rumen Modeling
- Fecal starch
- Corn silage KPS
- Manure Screening
- Corn micron size
- Penn State Box

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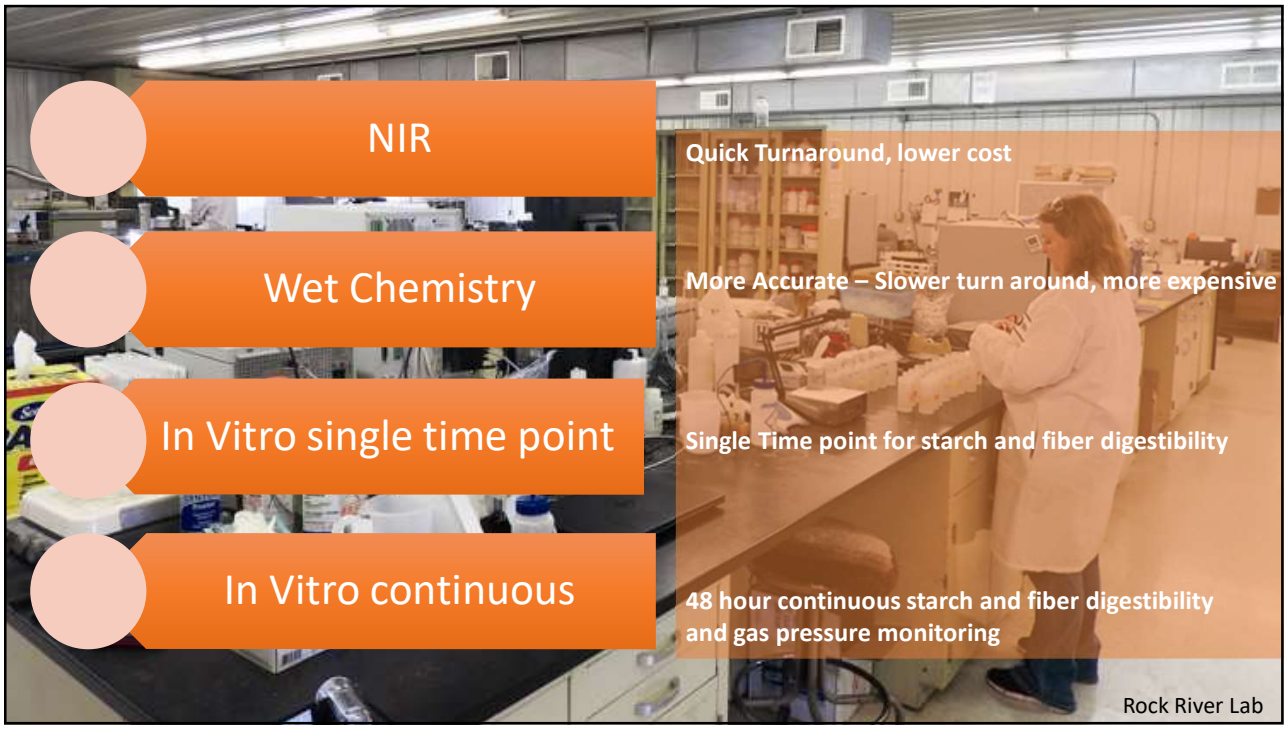

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8 reasons to use continuous In Vitro Model

1. TMR troubleshooting and benchmarking
2. Investigate the impact of feed changes on rations
3. Check overall digestibility of forages and byproducts
4. Investigate new season crop feed digestion rates
5. Monitor microbial biomass & CHO/Protein Synchrony
6. Compare extent and rate of digestion over 48 hours
7. Monitor associations and interactions of feeds
8. Opportunity to monitor methane and gas production

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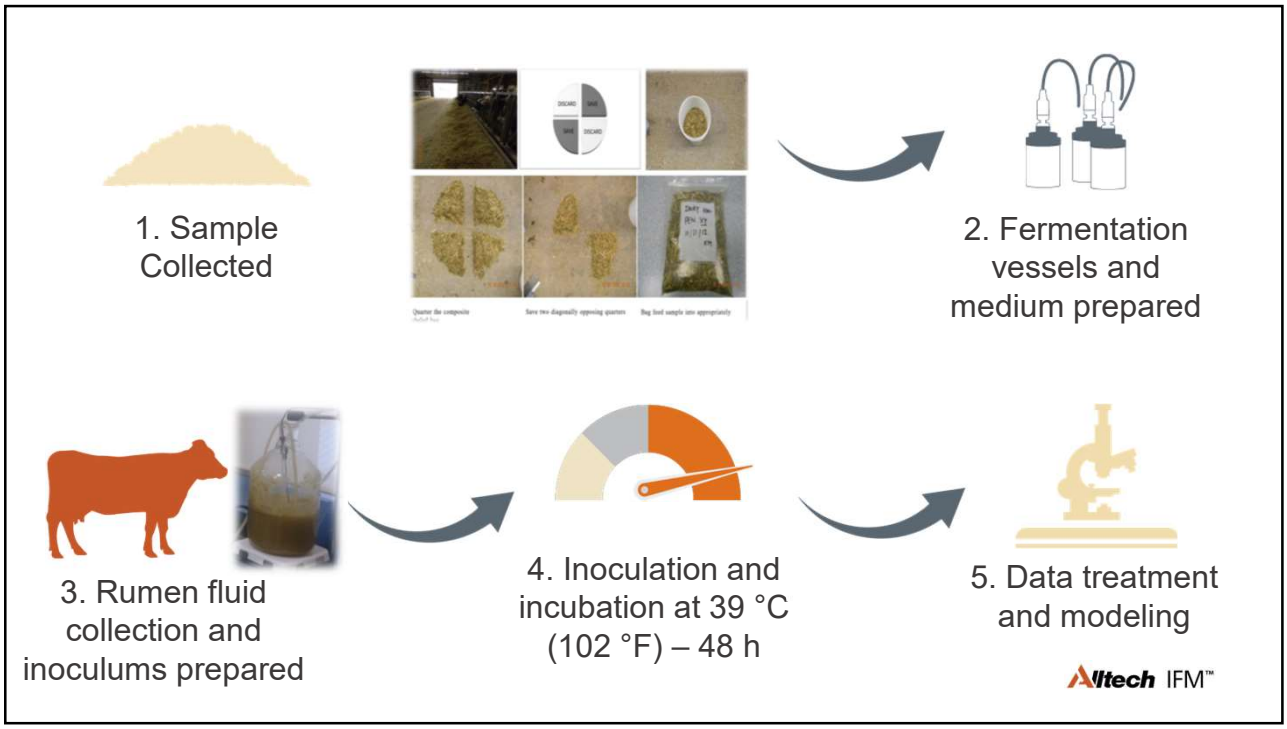
1. Sample Collected
2. Fermentation vessels and medium prepared
3. Rumen fluid collection and inoculums prepared
4. Inoculation and incubation at 39 °C (102 °F) – 48 h
5. Data treatment and modeling
Alltech IFM™

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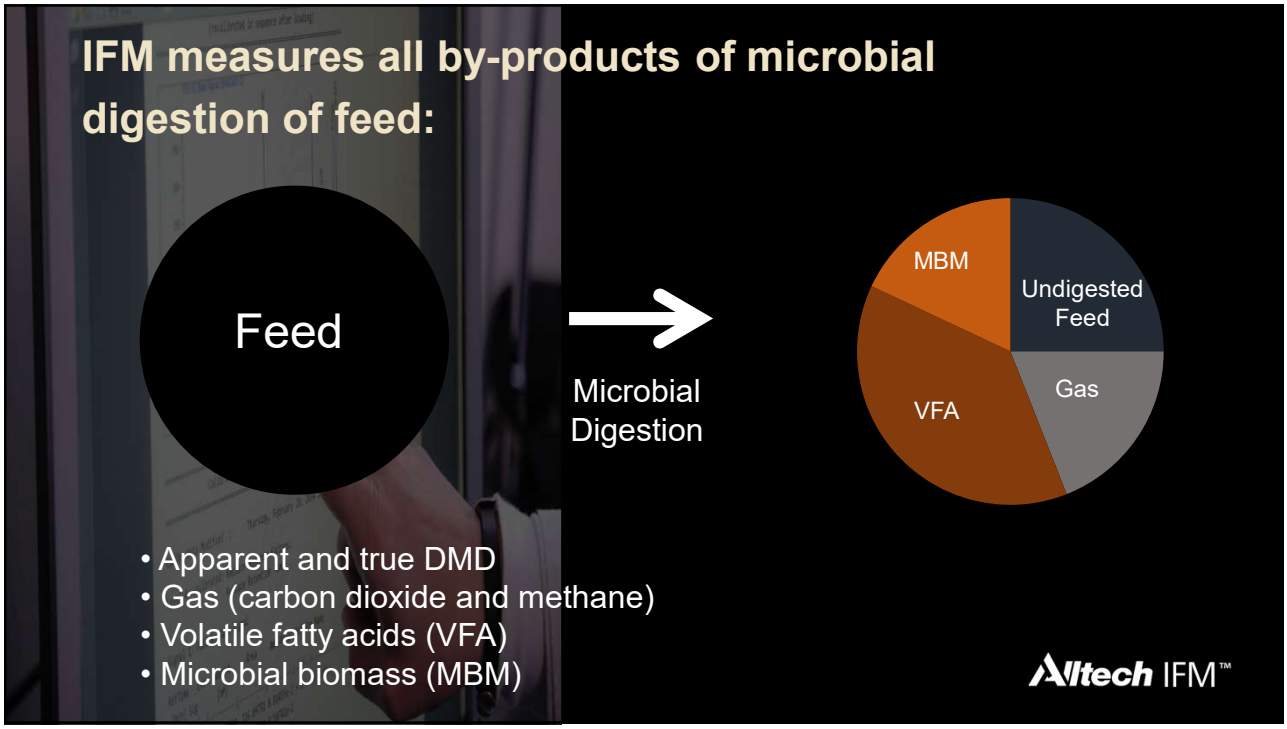
IFM measures all by-products of microbial digestion of feed:
Feed
Microbial Digestion
MBM
Undigested Feed
Gas
VFA
• Apparent and true DMD
• Gas (carbon dioxide and methane)
• Volatile fatty acids (VFA)
• Microbial biomass (MBM)
Alltech IFM™

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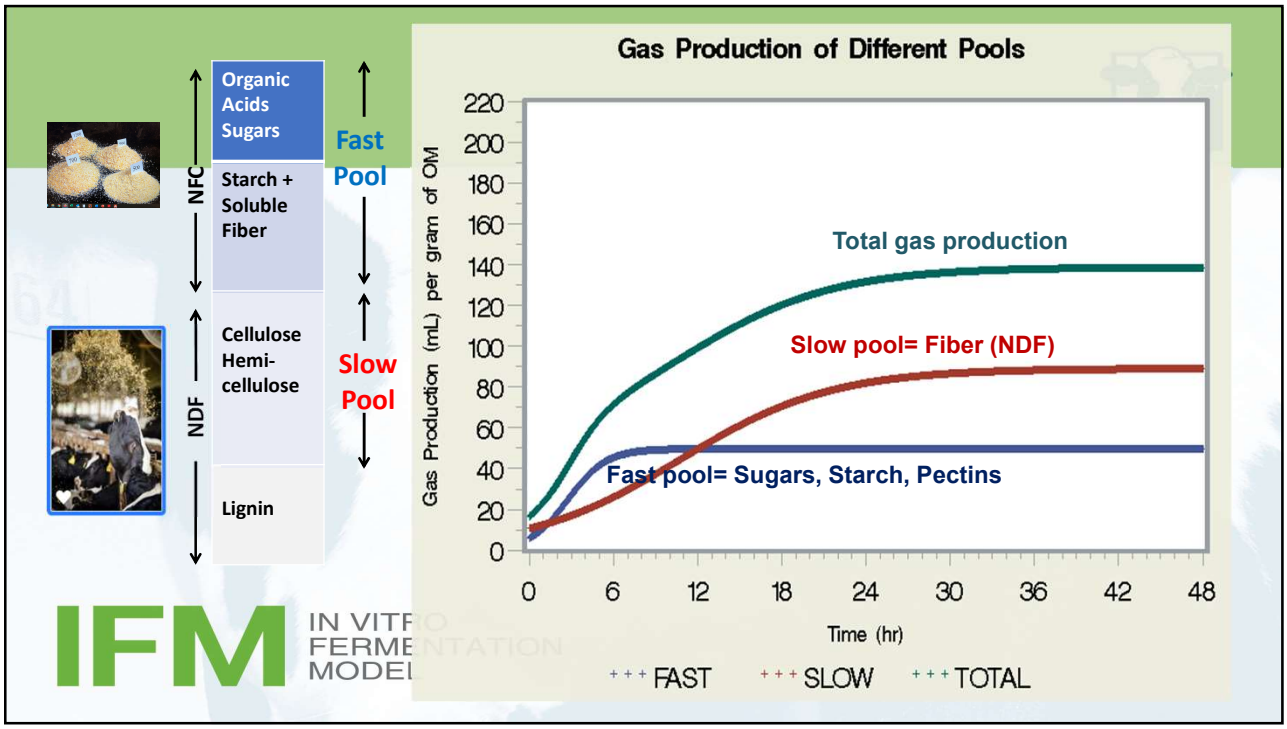
Organic Acids Sugars
Starch + Soluble Fiber
Cellulose Hemi-cellulose
Lignin
NFC
NDF
Fast Pool
Slow Pool
Gas Production of Different Pools
Gas Production (mL) per gram of OM
Total gas production
Slow pool= Fiber (NDF)
Fast pool= Sugars, Starch, Pectins
Time (hr)
FAST
SLOW
TOTAL
IFM
IN VITRO FERMENTATION MODEL

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Alltech IFM™
A global service to support the dairy business
Dr. Kamal Mjoun,
Ruminant Research, Alltech
Dr. Amanda Gehman
Ruminant Research, Alltech

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Relating IFM results to production

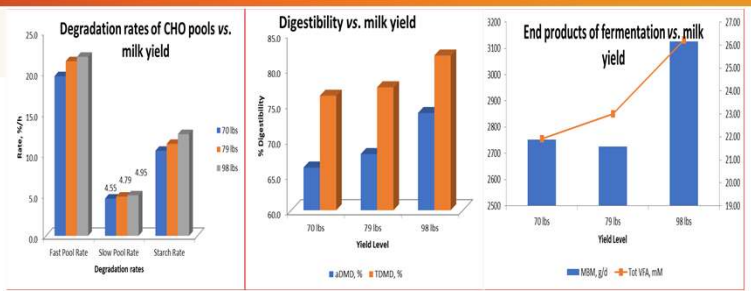
American Dairy Science Association®
MIDWEST
American Society of Animal Science

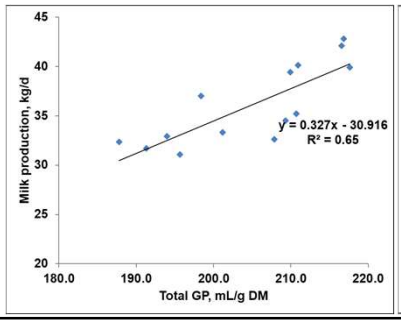
250 **Relationships between in vitro ruminal fermentation parameters and dairy performance.**
K. Mjoun[1,*], A. M. Gehman[2], [1]*Alltech, Brookings, SD,* [2]*Alltech, Inc., Nicholasville, KY*

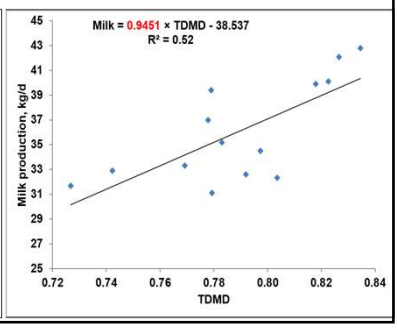
The in vitro gas production technique (IVGPT) is a valuable tool to evaluate feeds for ruminants by estimating the extent of digestion, rates of digestion of the different carbohydrates fractions, and end products of fermentation. One hundred sixty san ... ance (FCM, and ... FM, Alltech, Inc ... stages of lac- tati ... .2 ± 5.9 kg, FC ... M/DMI) 1.49 ± 0 ... ADF, starch, NF ... ± 4.28, 19.45 ± 3 ... 5% (DM ba- sis) ... in chemical con ... ion (FP) and

Milk yield predicted by:
- Slow pool rate
- Gas production
- VFA

Model	R^2
Milk yield= - 480 (43.55) + 38.44 (7.32) × SR* + 1.56 (0.393) × GP**+ 4.55 (1.53) × VFA**	0.95
FCM=- 490 (36.14) + 34.4 (6.07) × SR* + 1.57 (0.327) × GP* + 4.55 × VFA*	0.95
DMI= - 94.86 (19.29) + 10.27 (2.99) × SR* + 0.58 (0.124) × GP*	0.87
MY= - 448.5 (80.9) + 7.66 (1.17) × TDN**	0.82
DMI= 111.68 (12.66) + 11.86 (0.398) × NDF**	0.69







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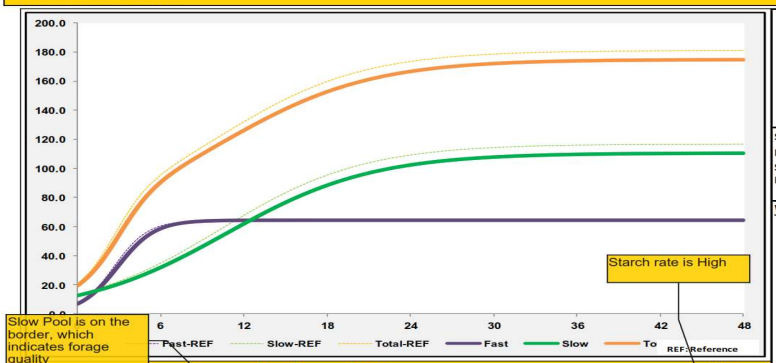
With adf and ndf the ration according to IFM is on the line. If you have a some stressors in the herd like forage changes, weather changes, mycotoxin or immune suppression, or overcrowding, you could potentially have some issues. The ration is pretty well balanced if you look at the lines in the green positions, just risky if there are outside stressors.



Starch rate is High

Slow Pool is on the border, which indicates forage quality

	Sample	Low	High
Pool Rates, %/h			
Starch, B1	16.67		
Fast Pool, A, B1, B2	18.59		
Slow Pool, B3	4.75		
Time to max rate, h			
Fast	2.92		
Slow	10.75		
Total gas pool, mL/g DM	174.91		
Proportion of gas, % of total			
Fast Pool	36.76		
Slow Pool	63.24		
TDMD, %	79.74		
Microbial biomass, mg/gDM	90.97		

Goal is to shoot for 3:66 fast pool to low pool. Could be where the bf depression is at.

TDMD is under 80, which indicates marginal forage quality. Goal is to be 82-84.

MBM is low indicating a shortage of RDP to the fast rate of starch

IFM IN VITRO FERMENTATION MODEL

Sender: John Winchell
Evaluator: Amanda Gehman
Sample Number: 170347
Product Description:

Wet Chemistry Results	Sample	Dry Basis Average	Normal Range
Dry Matter	44.09	48.1	38.8-63.5
Crude protein	17.72		
Soluble protein, %CP	25.72		
ADF	18.51		
aNDF	28.41		
AD-ICP	1.72		
AD-ICP, %CP	9.73	9.1	4.51-14.43
ND-ICP	3.52	4.1	2.35-6.14
ND-ICP, %CP	19.87	23.2	13.39-35.73
Lignin	2.72	2.92	1.43-5.17
Lignin, % NDF	9.57	9.21	4.81-15.67
Sugar	3.13	3.27	0.91-6.31
Starch	34.08	24.4	15.6-32.7
Fat	5.50		
Ash	6.20		
Calculated Values			
Adjusted Crude Protein	17.72		
NFC	42.17	36.7	27.4-45.1
TDN-1X	73.36	68.6	60.8-74.9
NE_{L-3X}, Mcal/lb	0.75	0.71	0.64-0.77
NE_{M-3X}, Mcal/lb	0.81	0.74	0.63-0.83
NE_{G-3X}, Mcal/lb	0.52	0.47	0.37-0.54

Soluble P is low in comparison to starch. This is why the MBM is on the low side

Starch level pretty high and add in the sugar = pretty high combo

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John Winchell, Alltech

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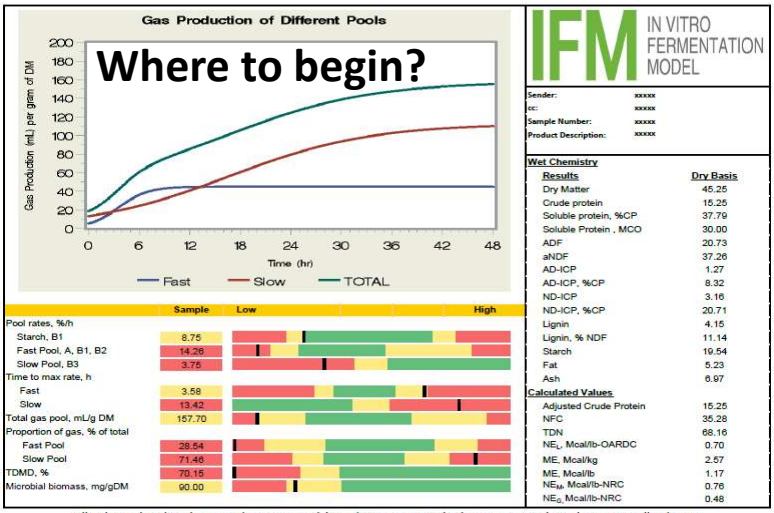
Troubleshooting



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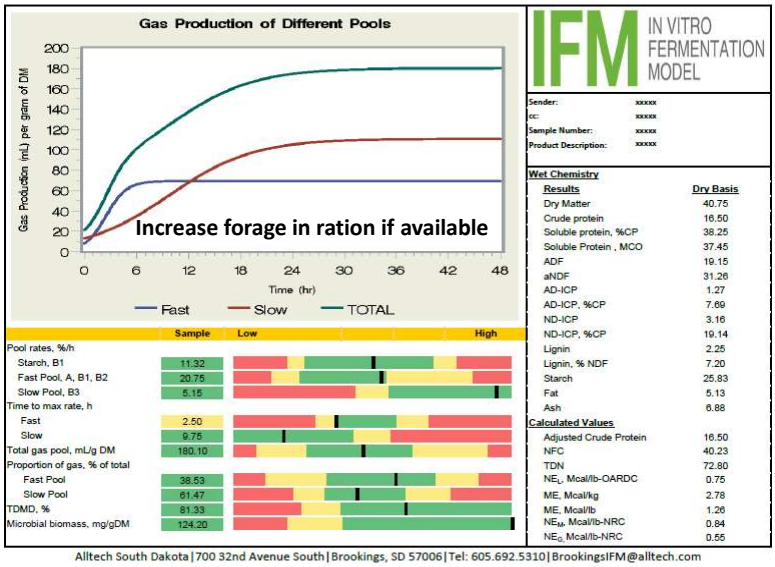
Identifying opportunities for reformulation



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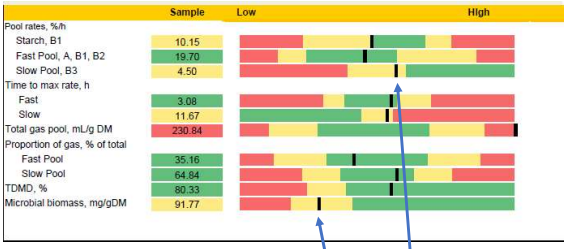
Before



- Inefficient conversation of feed energy and protein into microbial protein
- Ruminally available protein limiting
- Remove rumen undegradable protein
- Replace with rumen degradable protein.

Milk: 80 lb
DMI: 52 lb

After

- Replaced bloodmeal with soybean meal and slow-release NPN

Milk: 84 lb
DMI: 53 lb

Rations supplied by John Winchell, Reisdorf Bros., 2016

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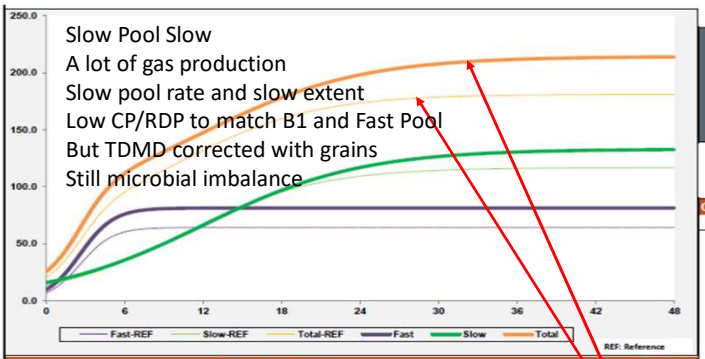

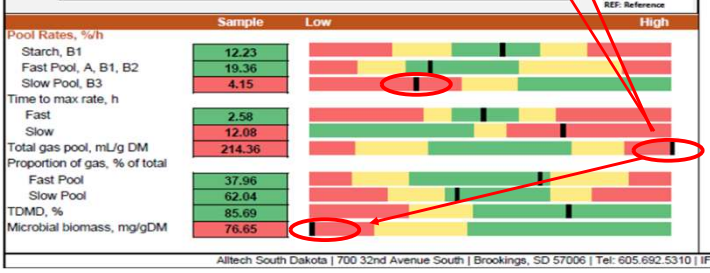

Sender: John Winchell
Evaluator: Amanda Gehman

12-21 TMR

Chemistry Results	Sample (Dry Basis)	Average	Normal Range
Dry Matter	42.29	46.71	37.17-61.04
Crude protein	15.62	16.83	14.62-19
ADF	21.09	20.34	16.11-24.87
aNDF	30.65	29.26	24.11-35.43
aNDFom	28.60	27.71	22.63-34.26
Lignin	2.76	3.27	1.86-4.46
Lignin, $\%NDF_{OM}$	9.65	11.22	6.32-15.14
AD-ICP	0.99	0.97	0.56-1.3
AD-ICP, %CP	6.34	5.85	3.21-7.72
ND-ICP	1.51	1.53	0.88-2.04
ND-ICP, % CP	9.65	9.19	5.17-12.12
Soluble Protein	43.47	41.67	31.4-54.8
Starch	26.65	25.42	16.04-32.12
Fat	5.01	4.80	3.32-6.41
Ash	6.04	7.92	6.22-10.37
Sugar, WSC	5.75	5.05	2.03-9.98
Calculated Values			
Adjusted Crude Protein	15.62	16.81	14.51-19
NFC	46.24	44.25	37.48-50.07
TDN	76.41	73.65	69.3-77.13
NEl, Mcal/lb	0.796	0.766	71.71-80.44
NEg, Mcal/lb	0.568	0.539	48.03-58.35
NEm, Mcal/lb	0.858	0.825	75.73-87.55

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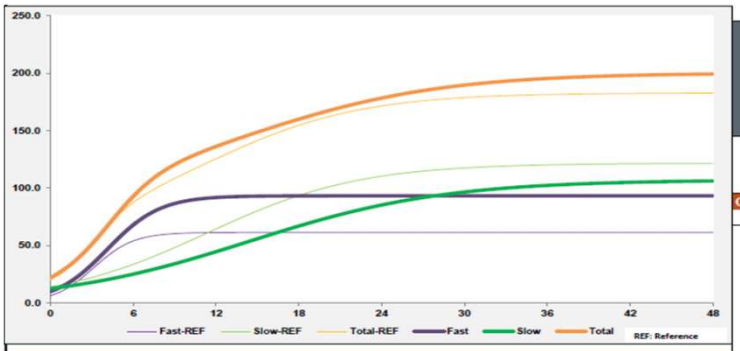

Sender: John Winchell
Evaluator: Amanda Gehman

Corn Silage

	Sample	Low	High
Pool Rates, %/h			
Starch, B1	12.27		
Fast Pool, A, B1, B2	13.08		
Slow Pool, B3	3.54		
Time to max rate, h			
Fast	4.17		
Slow	14.42		
Total gas pool, mL/g DM	200.23		
Proportion of gas, % of total			
Fast Pool	46.54		
Slow Pool	53.46		
TDMD, %	77.52		
Microbial biomass, mg/gDM	66.24		

Chemistry Results	Sample (Dry Basis)	Average	Normal Range
Dry Matter	31.93	35.38	29.34-48.49
Crude protein	8.44	7.92	6.39-9.27
ADF	23.79	23.07	18.84-29.14
aNDF	37.92	38.36	31.55-47.92
aNDFom	36.78	37.21	30.22-46.49
Lignin	3.07	2.86	1.28-3.64
Lignin, $\%NDF_{OM}$	8.35	7.01	3.34-9.49
AD-ICP	0.43	0.48	0.32-0.78
AD-ICP, %CP	5.09	6.10	4.05-9.87
ND-ICP	0.91	0.96	0.76-1.43
ND-ICP, % CP	10.78	12.14	9.62-18.1
Soluble Protein	61.14	61.20	37.39-84.99
Starch	32.07	34.13	23.89-42.56
Fat	4.00	3.48	2.45-4.27
Ash	4.33	3.61	2.65-5.61
Sugar, WSC	3.01	2.99	1.21-6.73
Calculated Values			
Adjusted Crude Protein	8.44	7.91	6.25-9.27
NFC	47.36	48.70	41.02-55.18
TDN	74.03	74.61	69.71-78.19
NEl, Mcal/lb	0.770	77.700	0.722-0.816
NEg, Mcal/lb	0.509	51.162	0.452-0.554
NEm, Mcal/lb	0.789	79.290	0.725-0.841

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Guidelines (based on Corn Silage)	Average	Recommended	Submitted Sample Values
2-Pool total (mL gas/g DM)	184.5	173.2-196.4	200.23
Fast Pool (mL gas/g DM)	56.1	48.4-61.2	93.19
Slow Pool (mL gas/g DM)	128.4	117.6-138	107.03
FP, % Total	30.4	26.8-33.7	46.54
SP, % Total	69.6	66.3-73.2	53.46
FP Rate (%/h)	20.83	17.57-23.63	13.08
SP Rate (%/h)	4.53	>4.53	3.54
Starch Rate (%/h)	12.37	11.06-13.37	12.27
Time to Max FP (h)	2.95	2.42-3.33	4.17
Time to Max SP (h)	11.65	<11.65	14.42
ADMD (%)	68.9	>65.86	71.76
TDMD (%)	74.4	>74.43	77.52
MBM (mg/g DM)	63.6	55.1-73.2	66.24
PF	4.05	3.81-4.24	3.87
Total VFA (mM)	25.37	23.47-28.04	30.98
Acetic Acid (% of total)	38.78	35.76-41.66	42.85
Propionic Acid (% of total)	34.84	33.29-36.32	31.71
Buytric Acid (% of total)	21.34	19.74-22.54	20.39
C2:C3	1.12	1-1.24	1.35

Observations

Fast pool (FP) rate is slow, indicating poor energy supply from quickly degrading starch and sugar.
Slow pool (SP) rate is slow, indicating poor forage quality.
Digestibility (TDMD) is good, indicating good potential energy supply.

Recommendations

Increase quickly degrading carbohydrates (e.g. steam flaked, high-moisture corn, molasses) to make up for slowly degrading grain in the corn silage.
Pair this corn silage with high quality forage to address suboptimal fiber digestion.
Amaize can help to increase rate of fast pool and improve starch utilization.
Fibrozyme can help to increase rate of slow pool and improve fiber digestion.

The suggestions/recommendations from the Analysis Report are based on the information and material the Customer has provided for the requested Service. The Company shall not be liable for any claim arising from any changes to the information disclosed by the Customer on the Submission Form.

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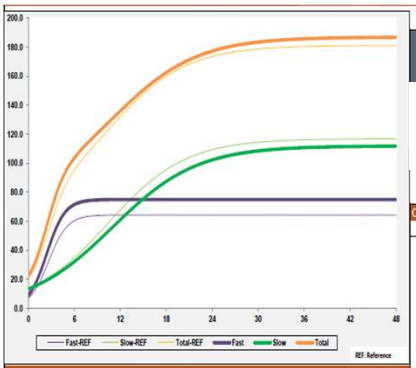
110 lbs Milk 3.6 Fat 2.9 Pro 13.4 Mun 7.23 lbs Components 63 lbs DMI



Sender: John Winchell
Evaluator: Amanda Gehman

Pool Rates, %/h	Sample	Low	High
Starch, B1	13.03		
Fast Pool, A, B1, B2	20.93		
Slow Pool, B3	4.55		
Time to max rate, h			
Fast	2.42		
Slow	11.08		
Total gas pool, mL/g DM	186.92		
Proportion of gas, % of total			
Fast Pool	40.13		
Slow Pool	59.87		
TDMD, %	83.31		
Microbial biomass, mg/gDM	121.46		

Chemistry Results	Sample	Dry Basis Average	Normal Range
Dry Matter	39.95	46.71	37.17-61.04
Crude protein	16.40	16.83	14.62-19
ADF	19.29	20.34	16.11-24.87
aNDF	27.84	29.26	24.11-35.43
aNDFom	25.96	27.71	22.63-34.26
Lignin	2.73	3.27	1.86-4.46
Lignin, $\%NDF_{OM}$	10.52	11.22	6.32-15.14
AD-ICP	1.08	0.97	0.56-1.3
AD-ICP, %CP	6.59	5.85	3.21-7.72
ND-ICP	1.63	1.53	0.88-2.04
ND-ICP, % CP	9.96	9.19	5.17-12.12
Soluble Protein	39.33	41.67	31.4-54.8
Starch	26.98	25.42	16.04-32.12
Fat	5.45	4.80	3.32-6.41
Ash	7.64	7.92	6.22-10.37
Sugar, WSC	6.38	5.05	2.03-9.98
Calculated Values			
Adjusted Crude Protein	16.40	16.81	14.51-19
NFC	46.18	44.25	37.46-50.07
TDN	76.07	73.65	69.3-77.13
NEl, Mcal/lb	0.793	0.766	71.71-80.44
NEg, Mcal/lb	0.570	0.539	48.03-58.35
NEm, Mcal/lb	0.860	0.825	75.73-87.55

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Guidelines (based on Dairy TMRs)	Average	Recommended	Submitted Sample Values
2-Pool total (mL gas/g DM)	177.2	169.6-185.5	186.92
Fast Pool (mL gas/g DM)	63.1	55.9-70.3	75.00
Slow Pool (mL gas/g DM)	114.1	106.8-121.2	111.92
FP, % Total	35.5	31.8-38.6	40.13
SP, % Total	64.5	61.4-68.2	59.87
FP Rate (%/h)	21.08	18.39-23.19	20.93
SP Rate (%/h)	4.83	>4.83	4.55
Starch Rate (%/h)	11.75	11.06-13.18	13.03
Time to Max FP (h)	2.66	2.33-2.92	2.42
Time to Max SP (h)	10.76	<10.76	11.08
ADMD (%)	73.0	>71	72.74
TDMD (%)	81.9	>81.9	83.31
MBM (mg/g DM)	102.1	90.9-111.4	121.5
PF	4.64	4.43-4.83	4.46
Total VFA (mM)	25.70	24.04-27.7	24.94
Acetic Acid (% of total)	44.29	42.1-46.41	46.68
Propionic Acid (% of total)	32.90	31.46-34.32	31.91
Buytric Acid (% of total)	17.82	16.67-18.8	16.88
C2:C3	1.36	1.24-1.47	1.46

Observations

Fast pool (FP) rate is good, indicating good energy supply from starch and sugar.
Slow pool (SP) rate is marginally slow, indicating suboptimal forage quality.
Digestibility (TDMD) is good, indicating good potential energy supply.
Microbial biomass (MBM) is good, indicating adequate ruminal protein supply.

Recommendations

Reduce inclusion of poorly digested forage (e.g. alfalfa silage) in favor of one with greater digestion (e.g. corn silage, alfalfa hay) or other digestible feedstuff.
Fibrozyme can help to increase rate of slow pool and improve fiber digestion.

The suggestions/recommendations from the Analysis Report are based on the information and material the Customer has provided for the requested Service. The Company shall not be liable for any claim arising from any changes to the information disclosed by the Customer on the Submission Form.

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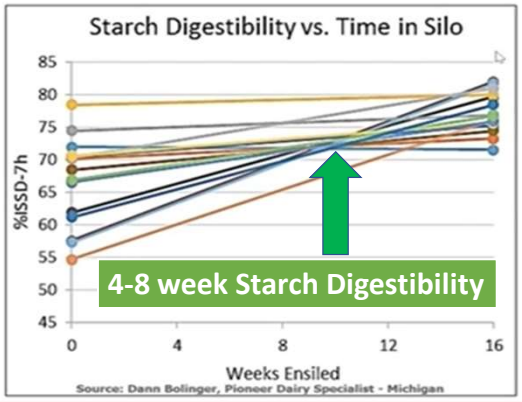
Opportunity….. Herds that do not have 3-4 month Carryover

Penn State **Extension**

Fresh Corn Silage Starch Digestibility

PDMP, 2018

ermented Storage on digestibility



4-8 week Starch Digestibility

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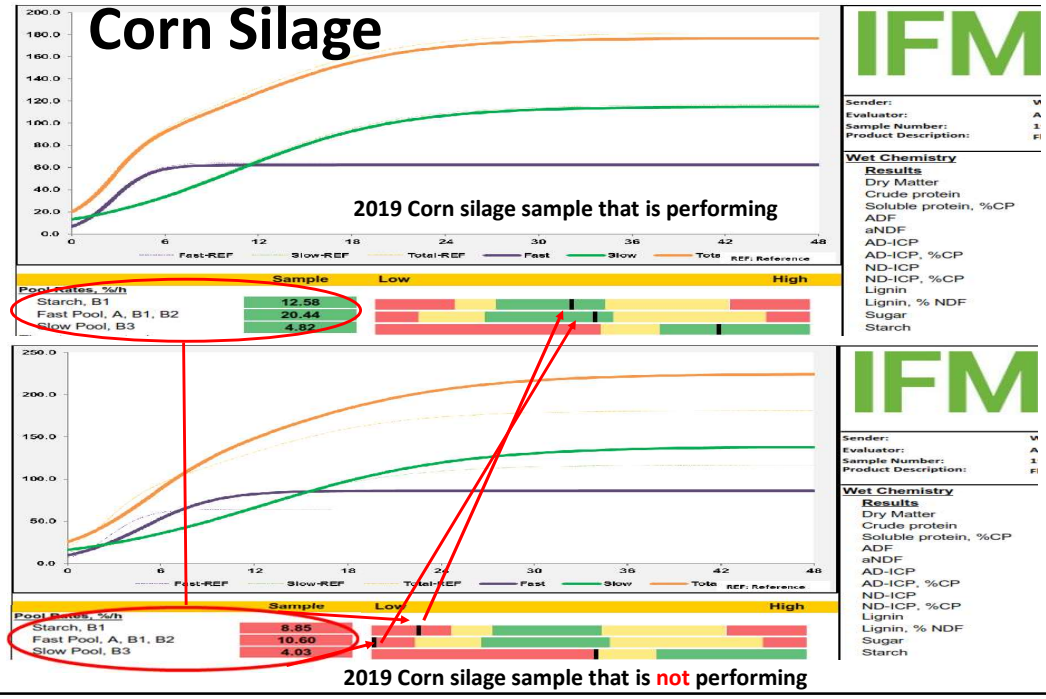

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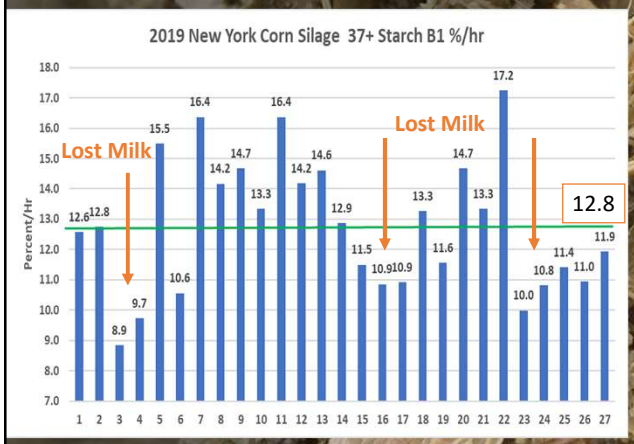
Corn Silage



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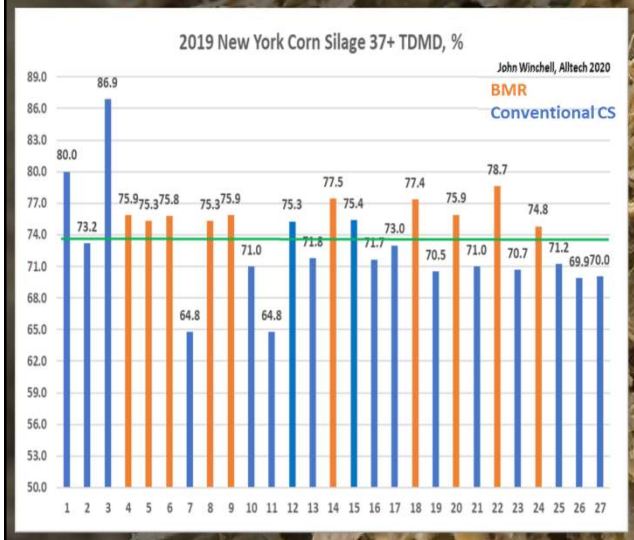
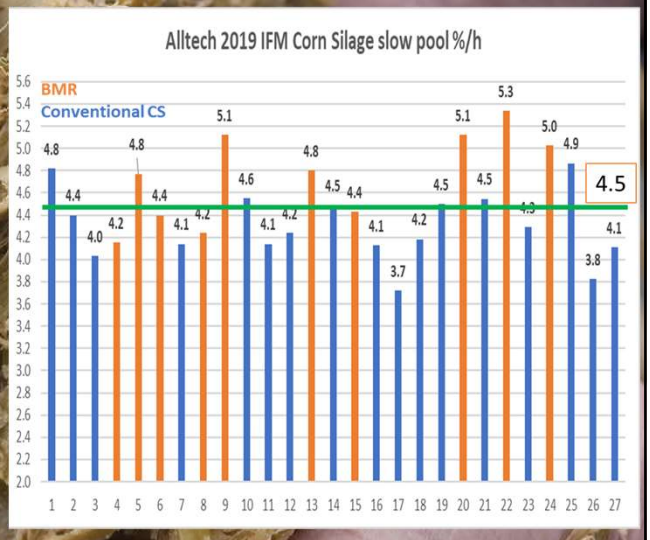
Corn Silage





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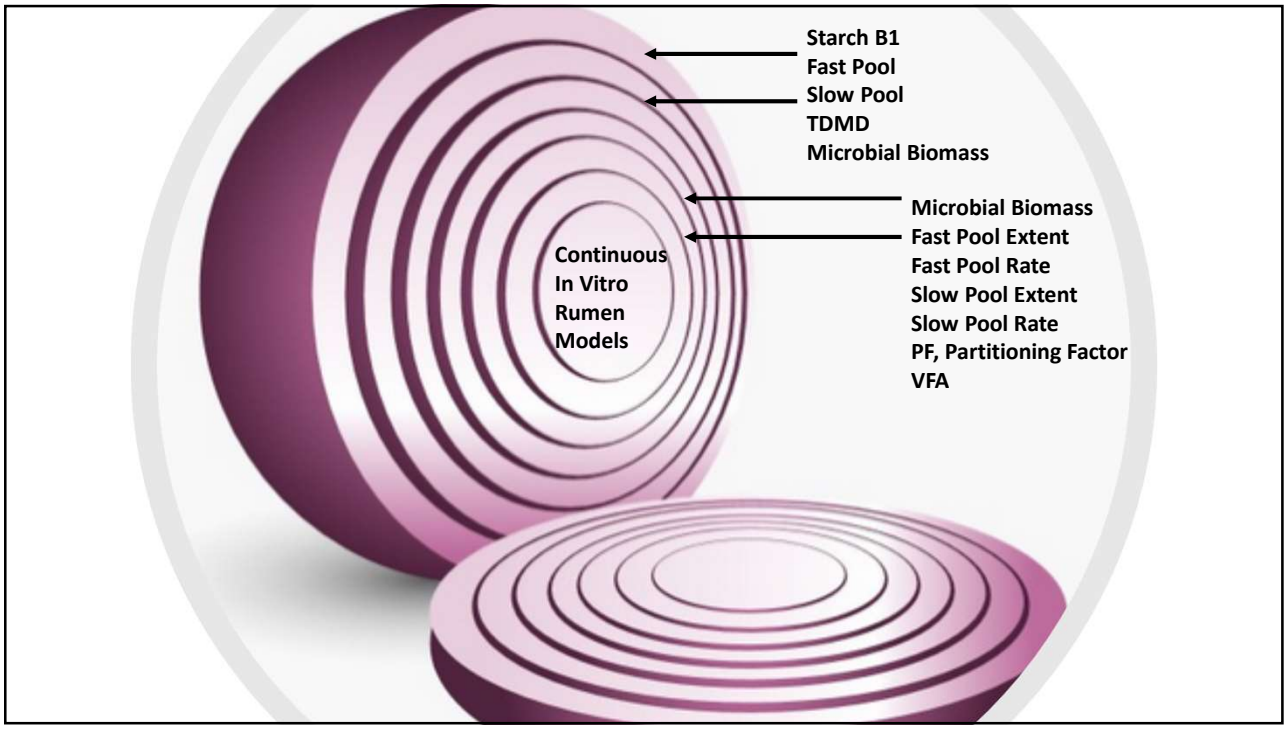

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Considerations

- Correct Sampling
- Particle Size
- Ration moisture
- Sorting
- Overcrowding
- Feeding times
- Push Up times
- Forage processing
- Grain processing

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Rumen Modeling
Harvest Analytics
Components
Other Solids
Fermentation
Denovo
Fecal Starch
Manure Screening

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Forage is one of the keys to profitability
Quality
Quantity

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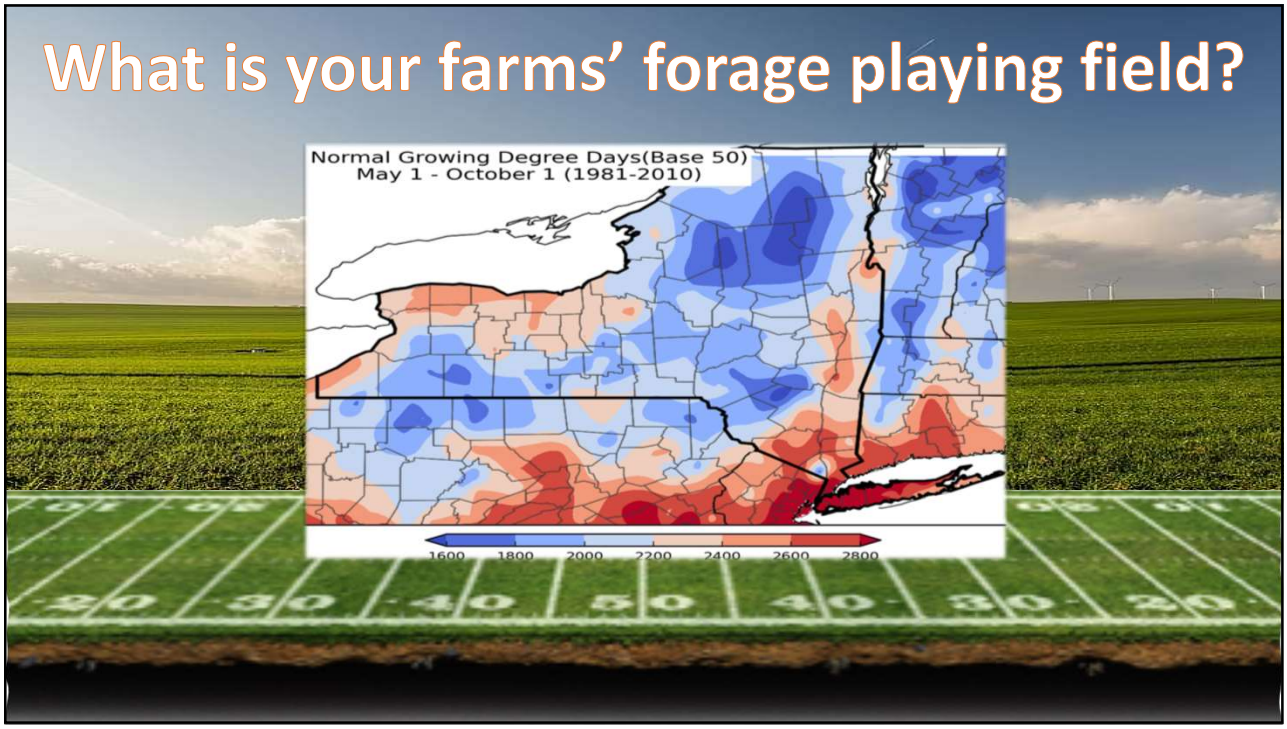
What is your farms' forage playing field?
Normal Growing Degree Days(Base 50)
May 1 - October 1 (1981-2010)
1600
1800
2000
2200
2400
2600
2800

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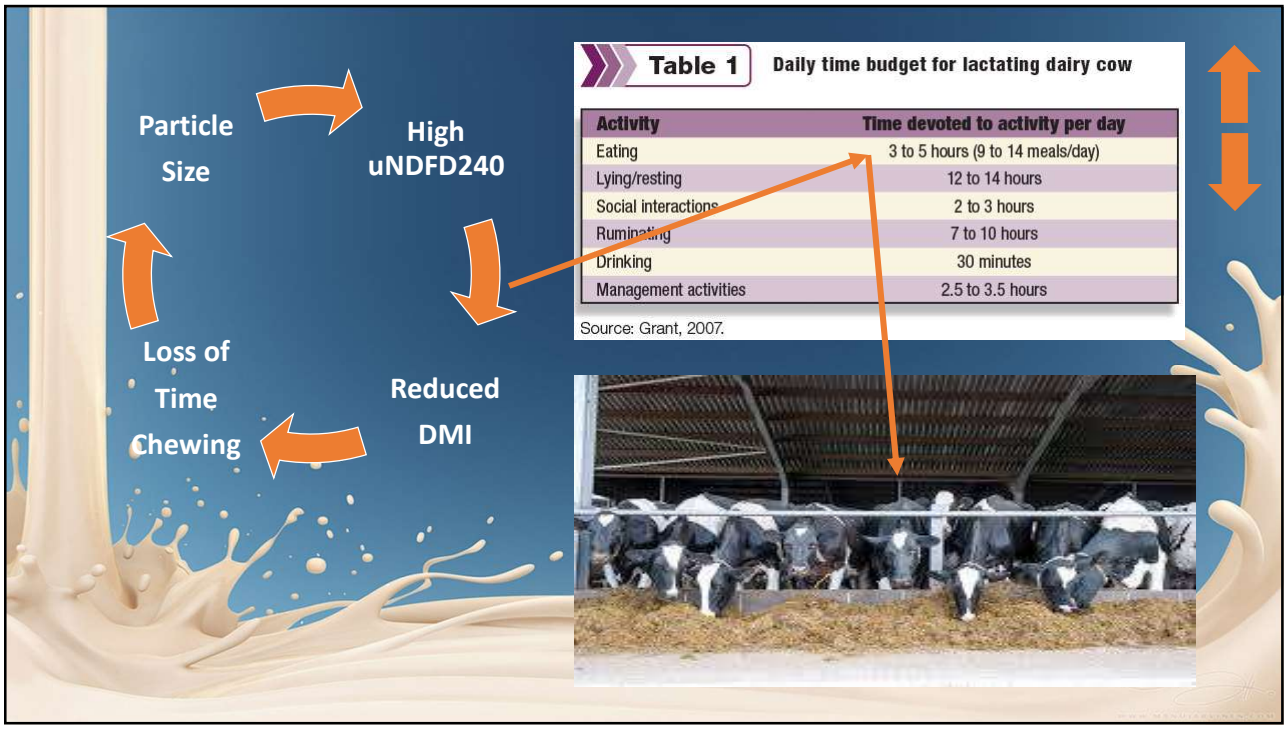
Particle Size
High uNDFD240
Reduced DMI
Loss of Time Chewing
Table 1 Daily time budget for lactating dairy cow
Activity | Time devoted to activity per day
Eating | 3 to 5 hours (9 to 14 meals/day)
Lying/resting | 12 to 14 hours
Social interactions | 2 to 3 hours
Ruminating | 7 to 10 hours
Drinking | 30 minutes
Management activities | 2.5 to 3.5 hours
Source: Grant, 2007.

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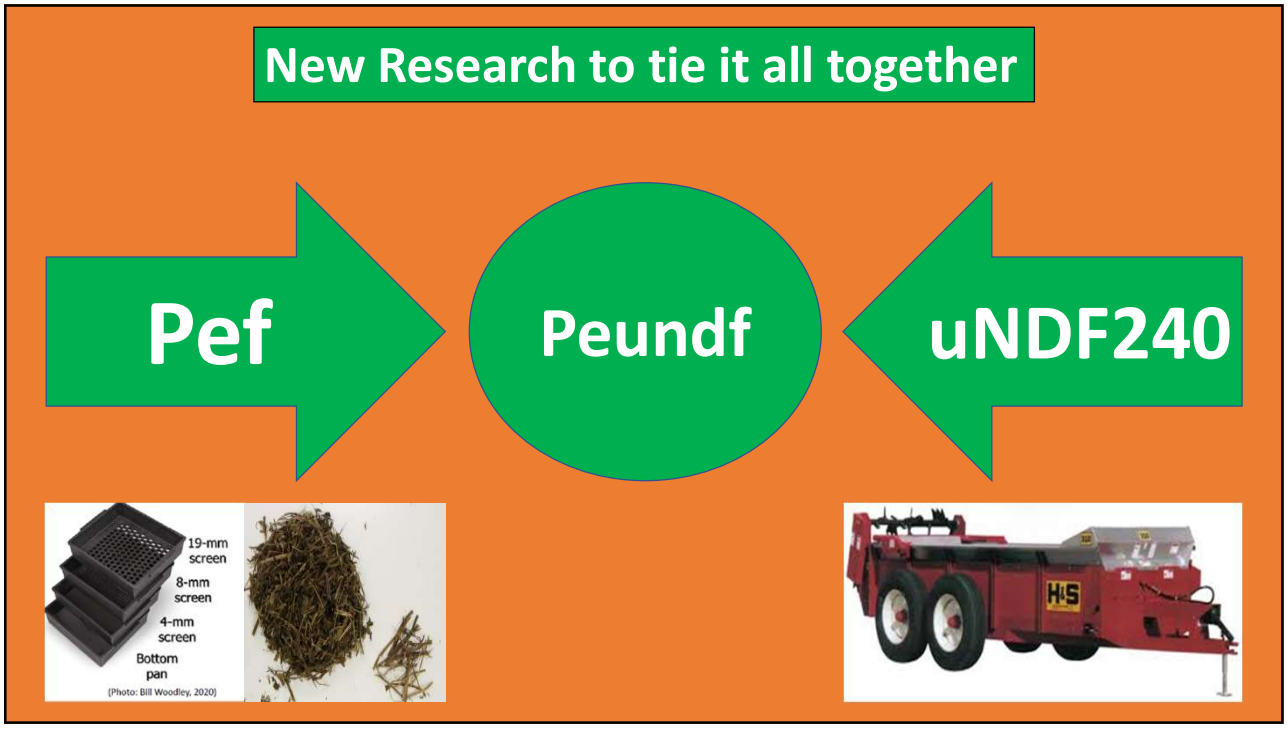
New Research to tie it all together
Pef
Peundf
uNDF240
19-mm screen
8-mm screen
4-mm screen
Bottom pan
(Photo: Bill Woodley, 2020)

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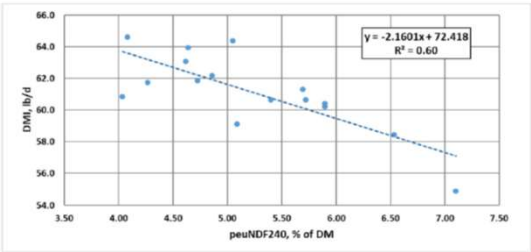
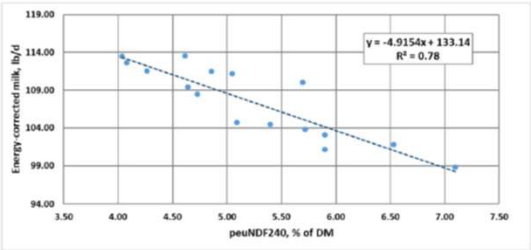
Dietary peuNDF240 and DM Intake



Miner Institute, 2020

Dietary peuNDF240 and ECM Yield



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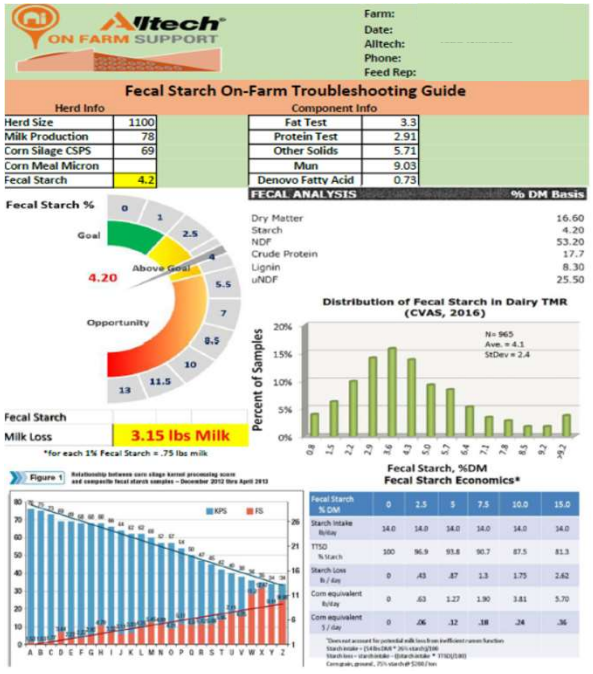

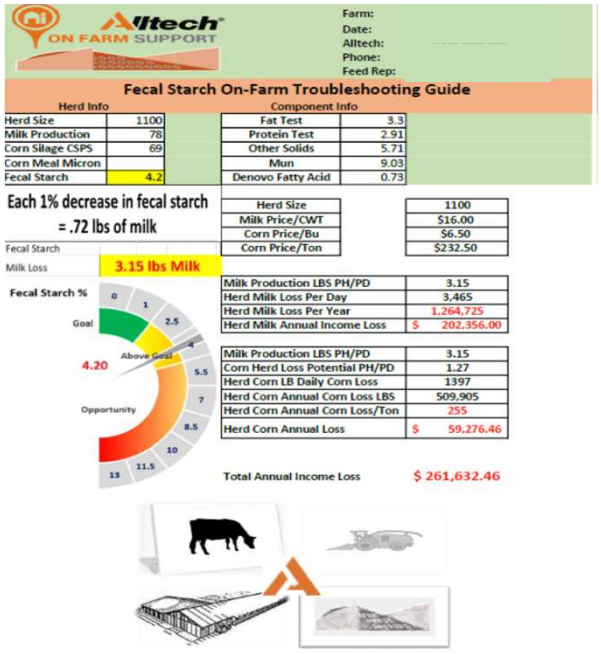

John Winchell, Alltech 2018

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Alltech® Manure screen and rumen function troubleshooting guide

Contact Info	
Date	
Farm Name	
Phone Number	
Nutritionist	

Herd Info		
Herd Size	1200	
Milk Production	78	
Fat Test	3.4	
Protein Test	2.9	
Mun	9	PEF%
Other Solids	5.73	Ration
		uNDF240 7.9
		PeuNDF

Misc Info	
Fecal Starch	2.4
Corn Silage CSPS	64
TMR Ration NDF	30.2

Herd observations

Denovo FA levels low, fat test low
High tmr top screen, low middle screen
Manure screen levels show high rate of passage. Wild yeast in TMR
Corn Silage fermentation instability could cause rapid fat degredation in combination with rumen function and rrapid rate of passage.

Alltech solutions to consider

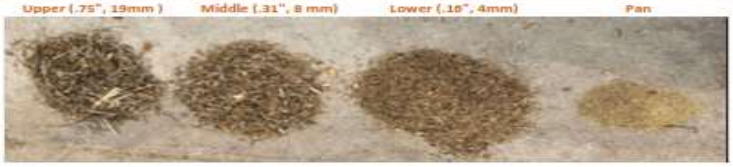
Yea-Sac for rumen function
Mold-Zap for wild yeast control
Optigen for increased fiber digestion

Prepared by: John Winchell | Phone Number: 585.447.1468

Penn State Shaker Data

	Upper (.75", 19mm)	Middle (.31", 8 mm)	Lower (.16", 4mm)	Pan	Total
Grams	185	210	321	41	757
% of Total	24	28	42	5	100
Ideal Range	2-8%	30-50%	10-20%	30-40%	
Variance	16	-22	22	-35	

Upper (.75", 19mm) Middle (.31", 8 mm) Lower (.16", 4mm) Pan



Manure screen data

	Top	Middle	Bottom	Total
Grams	230	80	151	461
% of Total	50	17	33	100
Ideal Range	10-20%	25-35%	50-55%	
Variance > Max	30	-8	-22	

Picture Top Picture Middle Picture Bottom

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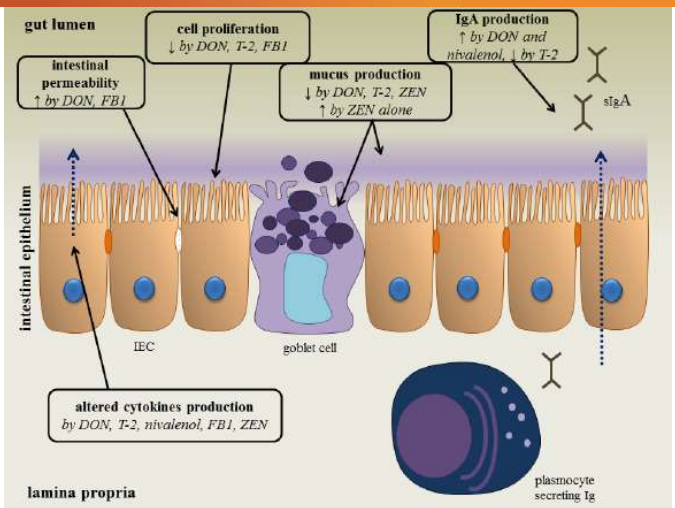
Influence of trichothecenes on GIT structure and function



1. Increase permeability by **reducing tight junction proteins**
   - Leaky gut
   - Altered nutrient absorption
   - Increased pathogen colonization/passage
2. **Damage villi** structure/function
3. Upregulate **cytokines/inflammation**

Antonissen et al., 2014

Alltech MYCOTOXIN MANAGEMENT

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Average Assessment for Performance Impairment for Dairy Cows (100% Inclusion of TMR)

Mycotoxin Group	Average Based on Inclusion, ppb	Lower, ppb	Moderate, ppb	Higher, ppb
Aflatoxin B1	0.0	50	100	150
Aflatoxins, Total	0.0	50	100	150
Ochratoxins/Citrinin	0.0	500	1000	1500
Type B Trichothecenes	914.7	500	1000	2000
Type A Trichothecenes	0.0	50	100	200
Fumonisins	835.5	10000	20000	30000
Zearalenones	41.2	100	250	500
Fusaric Acid	448.1	1000	2000	3000
Emerging Mycotoxins	136.3	1000	2000	3000
Other Penicillium Mycotoxins	19.8	50	100	200
Other Aspergillus Mycotoxins	0.6	50	100	200
Ergot Toxins	1.1	200	350	500
REQ	129.1	50	100	150

Southeast Mycotoxin Signature

DON	96%	914ppb
Fumonisin	96%	835ppb
Fusaric Acid	96%	431ppb
Emerging Toxins	92%	136ppb

Mycotoxin Concentrations in Selected Samples

Mycotoxin Group	Average, ppb	Maximum, ppb	Occurrence, %
Aflatoxin B1	0.00	0	
Aflatoxins, Total	0.00	0	
Ochratoxins/Citrinin	0.00	0	
Type B Trichothecenes	914.70	5,381	96.15
Type A Trichothecenes	0.00	0	
Fumonisins	835.46	3,917	96.15
Zearalenones	41.21	193	34.62
Fusaric Acid	430.87	1,754	96.15
Emerging Mycotoxins	136.25	339	92.31
Other Penicillium Mycotoxins	19.81	393	15.38
Other Aspergillus Mycotoxins	0.57	15	3.85
Ergot Toxins	1.14	25	7.69

Alltech MYCOTOXIN MANAGEMENT

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On farm mycotoxin analysis and analytics

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Questions?

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ON-FARM SUPPORT

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